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TABLE OF CONTENTS

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TABLE OF CONTENTS

Ahrenfeldt, R. H.
Two British Anatomical Studies on American Reptiles (1650-1750) II Edward Tyson: Comparative Anatomy of the Timber Rattlesnake 49

Allen, J. Frances and Robert A. Littleford
Observations on the Feeding Habits and Growth of Immature Diamondback Terrapins 77

Allen, William B., Jr.
Some Notes on Reptiles 228

Auffenberg, W.
Glass Lizards (**Ophisaurus**) in the Pleistocene and Pliocene of Florida 133

Barton, A. J.
Prolonged Survival of a Released Alligator in Pennsylvania 210

Bragg, Arthur N.
The Amphibia of Cherokee County, Oklahoma 25
Supplementary Notes on the Young of **Rana areolata** 87
Location of the Types of **Bufo terrestris charlesmithi** 151
The Tadpole of **Bufo debilis debilis** 211

Brattstrom, Bayard H. (see Phelan, Robert L.)

Bumzahem, Carlos B. and Hobart M. Smith
Additional Notes and Descriptions of Plethodontid Salamanders from Mexico 73
(see Smith, Hobart M.)

Burger, W. Leslie (see Smith, Hobart M.)

Carl, G. Clifford
Northward Extension of Known Range of the Tailed Frog, **Ascaphus truei** Stejneger 202

Carpenter, Charles C.
Sounding Turtles: A Field Locating Technique 120

Chrapliwy, Pete S. and Charles M. Fugler
Amphibians and Reptiles Collected in Mexico in the Summer of 1953 121

Clarke, Robert
Observations on **Eumeces s. septentrionalis** in Kansas 161

Clarke, Robert F. (See Wood, John Thornton)

Cunningham, John D.
Notes on Abnormal **Rana aurora draytoni** 149
Notes on the Ecology of **Thamnophis e. elegans** (Baird and Girard) 152
Arboreal Habits of Certain Reptiles and Amphibians in Southern California 217

Davis, William B.
A New Sheep Toad (Genus **Hypopachus**) from Mexico 71

Davis, William B. and James R. Dixon
Notes on Mexican Toads of the Genus **Tomodactylus** with the Descriptions of Two New Species 154

Dixon, James R. (see Davis, William B.)

Edgren, Margery K. (see Edgren, Richard A.)

Edgren, Richard A.
The Natural History of the Hog-nosed Snakes, Genus Heterodon: A Review 105

Edgren, Richard A. and Margery K. Edgren
Thermo-Regulation in the Musk Turtle, **Sternotherus odoratus** Latreille 213

Ferguson, Denzel E. (see Storm, Robert M.)

Fox, Wade
Mating Aggregations of Garter Snakes 176

Frazzetta, T. H.
An Anomalous Condition of the Liver of a Young **Python sebae** 184

Fugler, Charles M.
New Locality Records for the Louisiana Pine Snake, **Pituophis catenifer ruthveni** Stull 24
(see Chrapliwy, Pete S.)

Gates, Gerald O.
A Record Length for the Arizona Bull Snake **Pituophis melanoleucus affinis** from Arizona 235

Gordon, Robert E.
Additional Remarks on Albinism in **Microhyla carolinensis** 240

Hamilton, W. J., Jr.
Notes on the Ecology of the Oak Toad in Florida 205

Hays, M. Richard
Ultragulosity in the Frog **Rana aurora draytoni** 153
Herald, Earl S.
A Longevity Record for the Texas Blind Salamander 192
Hilton, William A.
Brain Chorioid Plexuses of Reptiles 169
Hoffman, Richard L.
On the Occurrence of Two Species of Hylid Frogs in Virginia 30
Hudson, Robert G.
Observations on the Larvae of the Salamander **Eurycea bislineata bislineata** 202
Johnson, Murray L. (see Lewis, Thomas H.)
Karlstrom, Ernest L. and Robert L. Livezey
The Eggs and Larvae of the Yosemite Toad **Bufo canorus** Camp 221
Kauffeld, Carl F.
Morbidity of Snakes in the Wild 236
Kerster, Harold Wm. and Hobart M. Smith
Rediscovery of a Mexican Lizard, **Barisia imbricata planifrons** (Bocourt) 191
The Identity of the Puerto Rican Species of **Phyllodactylus** (Reptilia: Squamata) 229
(see Smith, Hobart M.)
Lewis, Thomas H. and Murray L. Johnson
Observations on the Herpetofauna of the Mexican State of Nayarit 177
List, James C.
External Limb Vestiges in **Leptotyphlops** 15
Littleford, Robert A.
Another Record for **Cemophora coccinea** (Blumenbach) in Maryland 104
(see Allen, J. Frances)
Livezey, R. L.
A Northward Range Extension for **Bufo canorus** Camp 212
(see Karlstrom, Ernest L.)
Lowe, Charles H., Jr.
A New Subspecies of Urosaurus graciosus Hallowell with a Discussion of Relationships Within and of the Genus **Urosaurus** 96
The Evolutionary Relationships of the Narrow-lined Skinks of the Inland Southwest, **Eumeces taylori, E. gaigei,** and **E. multivirgatus** 233
(see Shannon, Frederick A.)
Lowe, Charles H., Jr. and Kenneth S. Norris
Analysis of the Herpetofauna of Baja California, Mexico III 89
Martin, James Robert and John Thornton Wood
Notes on the Poisonous Snakes of the Dismal Swamp Area 237
Murray, Keith F.
Herpetological Collections from Baja California 33
Norris, Kenneth S. (see Lowe, Charles H., Jr.)
Phelan, Robert L. and Bayard H. Brattstrom
Geographic Variation in **Sceloporus magister** 1
Pimentel, Richard A.
Habitat Distribution and Movements of **Bufo boreas boreas,** Baird and Girard 72
Riemer, William J.
Comments on the Distribution of Certain Mexican Toads 17
Schwartz, Albert
A Clutch of Eggs of **Aneides hardyi** (Taylor) 70
Shannon, Frederick A. and Charles H. Lowe, Jr.
A New Subspecies of **Bufo woodhousei** from the Inland Southwest 185
Shannon, Frederick A. and John E. Werler
Report on a Small Collection of Amphibians from Veracruz, with a Description of a New Species of **Pseudoeurycea** 81
Smith, Hobart M.
The Generic Name of the Alligator Snapper Turtle 16
Effect of Preservatives upon Pattern in a Mexican Garter Snake 165
(see Bumzahem, Carlos B.)
(see Kerster, Harold Wm.)
Smith, Hobart M. and Carlos B. Bumzahem
The Identity of the Trans-Isthmic Mexican Populations of the Malachite Tree Lizards (**Sceloporus malachiticus** Cope) 118

Smith, Hobart M. and W. Leslie Burger
Range Extensions of Certain Amphibians and Reptiles of Southern Mexico..... 75
Smith, Hobart M. and Harold W. Kerster
New and Noteworthy Mexican Lizards of the Genus **Anolis**..... 193
Smith, Hobart M. and Richard G. Van Gelder
New and Noteworthy Amphibians and Reptiles from Sinaloa and Puebla, Mexico.... 145
Smith, Hobart M. and Fred N. White
Adrenal Enlargement and Its Significance in the Hognose Snakes (**Heterodon**)..... 137
Smith, Hobart M. and Edward T. Willis, Jr.
Intraspecific Variation in Compression of Tail in a Cuban Lizard, **Anolis lucius**..... 86
Stebbins, Robert C.
Southern Occurrence of the Olympic Salamander **Rhyacotriton olympicus**..... 238
Stein, Hilda A.
The Range of the Cave Salamander in Illinois..... 153
Cnemidophorus sexlineatus Linnaeus in Illinois..... 228
Storm, Robert M.
A Possible Snake Hibernaculum..... 100
Storm, Robert M. and Denzel E. Ferguson
An Unusual Food Item of the Wandering Garter Snake..... 48
Thompson, Fred G.
Notes on a Small Collection of Reptiles from Coahuila, Mexico..... 182
Three Notable Records of the Marbled Salamander in Northern Ohio..... 183
Thurow, G. R.
Plethodon nettingi in Virginia..... 102
Van Gelder, Richard G. (see Hobart M. Smith)
Vernberg, F. John
Hematological Studies on Salamanders in Relation to Their Ecology..... 129
Werler, John E. (see Shannon, Frederick A.)
White, Fred N. (see Smith, Hobart M.)
Willis, Edward T., Jr. (see Smith, Hobart M.)
Wood, John Thornton (see Martin, James Robert)
Wood, John Thornton and Robert F. Clarke
The Dusky Salamander: Oophagy in Nesting Sites..... 150

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Geographic Variation in *Sceloporus magister*

By ROBERT L. PHELAN *and* BAYARD H. BRATTSTROM

INTRODUCTION

A superficial examination of individuals of the Desert Scaly Lizard, *Sceloporus magister* Hallowell, from widely separated localities reveals striking differences in pattern and coloration. The writers have for some time been aware of differences existing between populations from New Mexico and the deserts of California. The collection of several specimens from the Owens Valley of east-central California appeared to be quite different from either of the populations previously mentioned, and this led to a reappraisal of the entire group.

Five subspecies of *Sceloporus magister* have been recognized: *S. m. rufidorsum, S. m. monserratensis, S. m. zosteromus,* and *S. m. lineatulus* from Baja California, Mexico; and *S. m. magister* which occurs throughout all the rest of the range of the species, which includes most of southwestern United States and parts of northern Mexico.

Preliminary investigation revealed that no consistent or reliable scutellation differences existed in the United States population of *Sceloporus m. magister,* and that the major difference between populations is in the dorsal coloration of the males. The females and juvenile males have a fairly constant pattern, but the adult males exhibit marked and very consistent dorsal pattern differences. Four dorsal patterns are clearly discernible: 1. longitudinal stripes (black or red) of various widths, characterizing the Sonora and southern Arizona (black stripe), and the Baja California (red or light stripes) populations; 2. two longitudinal series of square or rectangular blotches, as seen in the eastern Arizona, New Mexico, and Texas populations; 3. uniform dorsal coloration showing no distinct pattern, prevalent throughout most of the range in California, northern Arizona, Utah, and Nevada; 4. six to seven dark crossbars, found in east-central California and west-central Nevada. These patterns are shown diagrammatically in Figure 1.

As mentioned above, the pattern of nearly all the females and juvenile males consists of numerous small blotches of irregular size and shape. Many of the females and juveniles from Inyo County, California, Sonora, southern Arizona, and parts of Baja California have a dorsal coloration which approaches the dorsal coloration of the males of their respective populations.

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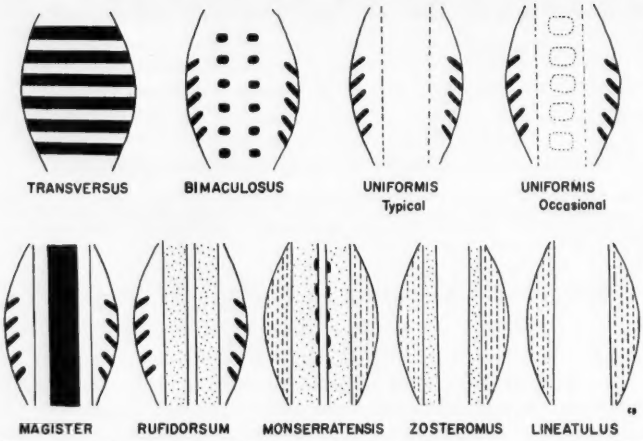

Figure 1. Diagrammatic drawings of the basic patterns of the dorsal surface of male *Sceloporus magister*.

Compilation of final data (Tables I-III) shows certain other minor differences in characters, such as tail/snout-vent ratio, number of scales across gular area, femoral pores, etc., but in no case are these differences statistically significant.

TABLE I. Summary of Measurements and Counts of *Sceloporus magister*

Subspecies	Max Snout-vent Length (mm.)	Tail L/ Snout-vent	Dorsal Scales	Femoral Pores
transversus	102	7 (1.2-1.5) 1.3*	3 (33-37) 35	3 (11-14) 11.5
bimaculosus	105	10 (1.3-1.6)1.3	15 (31-34) 33.2	28 (11-14) 12.6
magister	125	21 (1.1-1.5) 1.3	23 (39-35) 31	37 (11-15) 12.2
uniformis				
Cal. & Baja Cal.	128	28 (1.2-1.6) 1.4	31 (29-36) 32.5	50 (10-15) 12.7
San Joaquin Vly.	112	1 (1.4) 1.4	1 (30) 30	4 (12-13) 12.5
Nevada	100	6 (1.4-1.5) 1.4	9 (31-36) 33.2	13 (11-12) 11.5
Utah	93	13 (1.0-2.0) 1.5	6 (32-34) 33	10 (12-15) 13.5
Arizona	109	15 (1.4-1.6) 1.5	9 (31-40) 34	14 (11-16) 13.2
rufidorsum	131	6 (1.2-1.5) 1.4	8 (29-31) 29.8	14 (15-20) 17.9
zosteromus	98	———	86 (26-32) 29.3†	160 (16-22) 18.6†
monserratensis	108	2 (1.4) 1.4	— (27-32) 29†	3 (17-24) 20†
lineatulus	115	1 (1.8) 1.8	10 (28-31) 29.5†	20 (17-20) 19†

*Number (range) average
†Smith, 1939

TABLE II. Variation in Scale Counts of *Sceloporus magister*

Subspecies	Scales Across Gular Area	Supralabials	Infralabials	Supraoculars	Circum-orbitals
transversus	3 (18-20) 18.6*	6 (5-7) 5	6 (6-8) 6.5	6 (4-5) 5	6 (4-5) 5
bimaculosus	12 (16-20) 17.8	22 (4-6) 4.4	21 (5-8) 6.8	20 (4-5) 5	20 (5-9) 6.5
magister	23 (17-20) 17.8	9 (4-5) 5	9 (6-8) 6.7	10 (5-6) 5	10 (4-7) 5.3
uniformis					
Cal. & Baja Cal.	31 (17-21) 18	54 (4-6) 5	52 (5-8) 6.3	52 (4-6) 5.1	54 (3-7) 6.7
San Joaquin Vly.	1 (19) 19	2 (5) 5	2 (6) 6	2 (5) 5	———
Nevada	9 (17-21) 18.4	12 (4-5) 4.8	12 (6-8) 6	14 (5-6) 5.2	14 (4-7) 5.7
Utah	6 (16-19) 18	———	———	———	———
Arizona	10 (17-20) 18.7	5 (4-6) 5	7 (6-8) 7.3	8 (4-5) 4.5	8 (4-6) 5
rufidorsum	8 (15-18) 15.9	13 (4-5) 4.4	13 (5-7) 6.2	13 (5-6) 5.3	14 (3-6) 5.1

*Number (range) average

TABLE III. Variation in Ventral Coloration of *Sceloporus magister* Males

Subspecies	% of Arm Colored	Belly Patches			% of Thigh Colored
		Separate	United	% United	
transversus	13 (0-10) 0*	7	7	6 (0-100) 47	13 (0-90) 40
bimaculosus	6 (0-10) 0	6	2	2 (33) 33	7 (0-50) 26
magister	26 (0) 0	16	21	18 (0-90) 49	35 (0-100) 13
uniformis					
Cal. & Baja Cal.	31 (0-10) 0	10	24	24 (25-100) 80	32 (0-100) 38
San Joaquin Vly.	2 (0) 0	5	3	3 (12-50) 38	8 (0-50) 24
Nevada	26 (0-25) 0	3	23	23 (33-100) 63	26 (0-75) 38
Utah	12 (0) 0	7	5	5 (33-100) 63	12 (0-50) .08
Arizona	24 (0) 0	6	15	15 (0-100) 62	27 (0-100) 26
rufidorsum	8 (0-100) 100	2	6	6 (33-75) 57	8 (0-100) 64
monserratensis	1 (100) 100	2	0	0	2 (66) 66
lineatulus	1 (100) 100	0	1	1 (100) 100	1 (80) 80

*Number (range) average

The major problem that faced the writers was whether these populations, which can be distinguished primarily on the basis of the males, warrant subspecific recognition. We believe that they do, as the diagnostic characters of each population under question are consistent and the populations show intergradation near the borders of their ranges. These populations of *Sceloporus magister* thus appear to be natural units and therefore worthy of systematic recognition. It should be noted that in many groups of vertebrates (some *Anolis, Callisaurus,* most birds, some fish) only one sex can be "keyed out" to subspecies, though the populations are obviously distinct.

Since coloration is of primary importance in *Sceloporus* in mating, aggressive, and territorial behavior, it is to be expected that color is one of the more important factors to vary under selective processes. It should be obvious that color has more recognizable adaptive significance than most of the scale characters.

The population of *Sceloporus magister* found in Fresno and San Benito Counties, California, on the west side of the San Joaquin Valley, is the only population, as far as we can tell, that shows discontinuous distribution. It differs slightly from the Antelope Valley-Mohave Desert form, but, in our minds, not enough to warrant subspecific recognition. Perhaps this population (and the Pleistocene, Rancho La Brea specimens: Brattstrom, 1953) are remnants of a former wider range. This also appears to be true for *Xantusia vigilis*, which occurs along the west and south sides of the San Joaquin Valley as well as in Rancho La Brea. A third bit of evidence indicating a restriction of the range of a species in this area is the presence of fossil remains of *Gopherus agassizi* in the McKittrick Asphalt on the west side of the San Joaquin Valley, although today its most western occurrence is in the Antelope Valley.

There is some indication that the population in the floor (not the sides) of the Grand Canyon of Arizona are different (Lowe ms.). In addition, the subspecies described below from New Mexico, Texas, Chihuahua, and northern Durango may possibly be divided into several groups when more material is available.

Although we have seen most of the available specimens of *Sceloporus magister*, we do not repeat here the complete synonymies or all the specimens available, as these can be found in Smith (1939).

ACKNOWLEDGMENTS

We wish to thank the following people for loan of specimens (initials indicate abbreviations of institutions used in this paper). Dr. L. M. Klauber, San Diego Society of Natural History (LMK and SDSNH); Dr. Doris M. Cochran, U. S. National Museum (USNM); Dr. Hobart M. Smith, University of Illinois (UI); Dr. Robert G. Stebbins, Museum of Vertebrate Zoology, University of California, Berkeley (MVZ); Mr. Joseph R. Slevin, California Academy of Sciences (CAS); Mr. Jay Savage, Stanford University Natural History Museum (SU); Dr. C. H. Lowe, Jr., University of Arizona (UA); and Dr. Raymond B. Cowles, University of California, Los Angeles (UCLA).

We wish also to thank Dr. Doris M. Cochran for making notes for us on the type specimen of *Sceloporus m. magister* in the U. S. National Museum and Drs. Raymond B. Cowles, Hobart M. Smith, and Thomas R. Howell for their suggestions and criticisms.

This work was supported by a grant from the Richfield Oil Corporation under the direction of Dr. Raymond B. Cowles.

The SUBSPECIES OF *Sceloporus magister*

Sceloporus magister magister Hallowell

Sceloporus magister Hallowell, Proc. Acad. Nat. Sci. Philadelphia, vol. 7, 1854, p. 93; Stejneger, North Amer. Fauna, no. 7, 1893, pp. 160, 178-183.

Sceloporus magister magister, Linsdale, Univ. Calif. Publ. Zool., vol. 38, 1932, p. 365; Smith, Publ. Field Mus. Nat. Hist. Zool. Ser., vol. 26, 1939, pp. 145-161.

Type. U.S.N.M. 2967; A. L. Heermann, collector.

Type Locality. Fort Yuma, Arizona.

Diagnosis. Adult males characterized by a black or deep purple mid-dorsal stripe approximately 4½ to 5 scales wide from just posterior to the head to the middle of the back or tail, bordered laterally by a light

stripe on each side. Dorsal scales average 31.0, femoral pores average 12.8, adults average somewhat larger than other forms in species. The shoulder patch usually extends dorsally to meet the anterior edge of the black dorsal stripe.

Range. Sonora, Mexico, including Tiburon Island, and southern Arizona. It intergrades with the more northern subspecies along a line from the California border east to Phoenix, Arizona, and then south to Tucson. It apparently does not cross the Colorado River into California or Baja California, though some indications of black stripes are seen in individuals from Imperial County.

We have seen one series from Tiburon Island, Gulf of California (CAS 53356-59), which contains only one adult male, but this individual has the femur colored ventrally 100%, whereas the mainland population has only 0 to 33% of the femur colored. More material may support recognition of this island population as a distinct race.

Referred Material. SONORA: 25 mi. E. Altar (UI 23980), 1 mi. S. Altar (UI 23995-97), 28 mi. S. Santa Ana (UI 23982), 45 mi. S. Santa Ana (UI 23983, 23985-87), 4 mi. N. Navajoa (UI 23984), 43 mi. S. Hermosillo (UI 23988-94), 24.8 mi. N.E. Punta Penasco (UI 1892-93), Guaymas (UI 21323, LMK 4068), 2 mi. S.W. Los Alsenos (LMK 29659), 3 mi. S. Sonoyta (LMK 38612-13), 5 mi. S.W. Pt. Sipiano (LMK 39188), Carbo (LMK 2881-82), Camoa (USNM 46846), Patomotac (USNM 47264), Toban Bay (LMK 466), Noria (EHT 8341-42, Smith, 1939), Tiburon Island, Gulf of California (CAS 53356-59). ARIZONA: Maricopa County—12.9 mi. N. Ajo (UI 30317), Wickenburg (LMK 32375); Mariposa County—Cave Creek (CAS 17287); Pima County—San Xavier Mission (LMK 40910), San Simeon (LMK 33276), Organ Pipe Cactus National Monument (UI 6031, SDSNH 17845), Catalina Mts. (CAS 48484-85, 34174-75, 34318, 34303), 1.5 mi. W. Ventana Ranch Headquarters (UA 492), Tucson (UA 4); Pinal County —25 mi. W. Casa Grande (LMK 35070); Yuma County—Fort Yuma (USNM 2967, TYPE), Yuma (LMK 34965), Castle Dome (SDSNH 15732).

Sceloporus magister rufidorsum Yarrow

Sceloporus rufidorsum Yarrow, Proc. U. S. Nat. Mus., vol. 5, 1882, pp. 442-443 (part).

Sceloporus magister rufidorsum, Linsdale, Univ. Calif. Publ. Zool. vol. 38, 1932, p. 366; Smith, Publ. Field Mus. Nat. Hist. Zool. Ser., vol. 26, 1939, pp. 161-165.

Type. U.S.N.M. 11981; L. Belding, collector.

Type Locality. "San Quentin Bay," Baja California. In Yarrow (1882), the type locality is listed, "La Paz, California."

Diagnosis. Adult males characterized by rusty red dorsal stripes from the posterior part of the head to the tail with a thin light-colored stripe 1½ to 2½ scales wide, mid-dorsally. Dorsal scales average 29.8, ventrals average 41, femoral pores average 17.9, scales across the gular area average 15.9.

Range. Northern Baja California, Mexico, except extreme northeastern part, and south as far as the Vizcaino Desert. Also known from Cedros Island.

Referred Material. BAJA CALIFORNIA: "San Quentin Bay" (USNM 11981, TYPE), Ensenada (LMK 2396, 23716; SDSNH 11549; USNM 37661-62), 22 mi. S. Cataviña (LMK 3022-24), Santa Gertrudies Mission (SDSNH 17477, 17528), San Borjas (Lat. 29°) (SDSNH 17701-02), 2 mi. N. Cataviña (UCLA 5381-83), Punta Prieta (UCLA 444), San Telmo (MVZ 9728-30), Valladares (MVZ 9734), San Ramón (MVZ 9727, 9885-86), Socorro (MVZ 13576), El Rosario (MVZ 13559-75), Cedros Is. (LMK 5224-35, 7250-51, 24301-11, 27688-91; SDSNH 115907-17, 17312-19, 17351-58; UCLA 1338, 1367, 1396; AMNH 5474, 5476; USNM 64473; MVZ 9691-94).

Sceloporus magister monserratensis Van Denburgh and Slevin

Sceloporus monserratensis Van Denburgh and Slevin, Proc. Calif. Acad. Sci., Ser. 4, vol. 11, 1921, p. 396.

Sceloporus magister monserratensis, Smith, Publ. Field Mus. Nat. Hist. Zool. Ser., vol. 26, 1939, pp. 165-168.

Sceloporus magister rufidorsum, Linsdale, Univ. Calif. Publ. Zool. vol. 38, 1932, p. 366 (part).

Type. C.A.S. 50509; Joseph R. Slevin, collector.

Type Locality. Monserrate Island, Gulf of California, Mexico.

Diagnosis. Adult males distinguished by a narrow light-colored mid-dorsal band 1½ to 2 scale rows wide, usually with a row of dark spots along each lateral border. Dorsal scales average 32, ventrals average 37, femoral pores average 20.0. Lateral scale rows with continuous or somewhat broken oblique dark lines. Shoulder patch with light posterior border.

Range. Baja California, Mexico, from the southern part of the Vizcaino Desert south, but excluding the cape; and on the surrounding islands, including Monserrate, Magdalena, Santa Margarita, San Jose, and Coronado (Gulf) Islands.

Referred Material. BAJA CALIFORNIA: Turtle Bay (LMK 4060, *rufidorsum* intergrade), Santa Teresa Bay (LMK 4061), Magdalena Island (LMK 30197-208; MVZ 13611-17), Santa Margarita Island (LMK 4065; MVZ 13618-22), San José Island, Gulf (MVZ 11726-27; LMK 4063-64, 6848-49; CAS 52687-92), Coronado Island, Gulf (LMK 30219-21), Monserrate Island, Gulf (CAS 50509, TYPE; CAS 52256-78), Comondú (LMK 30213-15; MVZ 13589-90), Loreto (LMK 30216-18), San Ignacio (MVZ 10650-52, 10655, 10657-58, 13593-96, 13598, 13600-06; LMK 4055-59).

Sceloporus magister zosteromus Cope

Sceloporus zosteromus Cope, Proc. Acad. Nat. Sci. Philadelphia, 1863, p. 105; Stejneger, North Amer. Fauna, no. 7, 1893, pp. 178, 181.

Sceloporus magister zosteromus, Linsdale, Univ. Calif. Publ. Zool., vol. 38, 1932, p. 366; Smith, Publ. Field Mus. Nat. Hist. Zool. Ser., vol. 26, 1939, pp. 170-172.

Type. U.S.N.M. 5298 (23 specimens), 69472-69488; John Xantus, collector.

Type Locality. Cape San Lucas, Baja California, Mexico.

Diagnosis. Adult males distinguished from *S. m. monserratensis* in having a broad mid-dorsal light stripe 6 scales wide and in the absence of distinct bordering dark lines or spots. Dorsal scales average 29, ventrals

average 41, femoral pores average 18.5. Lateral scales with discontinuous oblique dark lines.

Range. Cape region of Baja California, Mexico, and Espíritu Santo Island.

Referred Material. BAJA CALIFORNIA: Cape San Lucas (USNM 5298, TYPE; LMK 2733, 10775-77, 30173-79, 30290-03; SDSNH 17705; AMNH 5437, 5473), La Paz (LMK 30180, 30185; SDSNH 17704), Todos Santos (LMK 30181-84; MVZ 11712-25), San José del Cabo (SDSNH 17699-700; USNM 64468-71), Triunfo (MVZ 13623-24), Eureka (MVZ 11733), Agua Caliente (MVZ 11729-32), Santa Anita (MVZ 11728), Espíritu Santo Island (AMNH 5486, Smith, 1939).

Sceloporus magister lineatulus Dickerson

Sceloporus lineatulus Dickerson, Bull. Amer. Mus. Nat. Hist., vol. 41, 1919, pp. 467-468.

Sceloporus magister lineatulus. Smith, Publ. Field Mus. Nat. Hist. Zool. Ser., vol. 26, 1939, pp. 168-170.

Type. U.S.N.M. 64263; C. H. Townsend, collector.

Type Locality. Santa Catalina Island, Gulf of California, Mexico.

Diagnosis. Characterized by lack of dorsal striped pattern and lack of light posterior border of dark shoulder patch. First canthal in contact with lorilabials. Dorsal scales average 39.5, ventrals average 40, femoral pores average 19.

Range. Known only from Santa Catalina Island, Gulf of California, Mexico.

Referred Material. Santa Catalina Island, Gulf of California (USNM 64263, TYPE; AMNH 5477, Paratype; LMK 6847; MVZ 32429; CAS 52311-19).

Sceloporus magister uniformis new subspecies

Type. U.C.L.A. 1812, collected by Dr. Raymond B. Cowles, June 14, 1943.

Type Locality. Valyermo, Los Angeles County, California.

Diagnosis. A *Sceloporus magister* characterized by lack of any distinct markings (bars, stripes, or blotches) on the dorsum of the adult male, but with a uniform light yellow or tan across the entire back grading into darker brown on sides. Dorsal scales 29-40 (average 33), femoral pores 10-16 (average 13).

Description of Type. An adult male, snout-vent length 95 mm., tail length 140 mm. Dorsal scales 32 from parietal to just posterior to thigh, ventral scales 37 from gular patch to femoral pores, scales around body 38, femoral pores 13-12, scales across the gular area from ear to ear 18, supraoculars 6-6, circumorbitals 7-5, fifth supraocular touched by most posterior circumorbital, supralabials 6-5, infralabials 8-8, auricular lobules 5-5, lamellae of fourth hind toe 15-16.

Coloration (in alcohol): Over-all ground color light tan, top of head lighter and slightly mottled with dark. Thin dark eyestripe present, extending 3-4 scales behind the eye. Shoulder patches do not meet at the top, separated by 5 scale rows of lighter color. Entire dorsum from parietals to middle of tail without markings. Gular patch present, joined to shoulder patch through a blue-black area 3 scales wide. Anterior two-thirds of belly patches confluent, posterior one-third separated by white

area 5 scales wide at the maximum. Belly patches not touching gular patch or shoulder patch. Groin and proximal half of thigh with dark coloring which is confluent with belly patch. Sides greenish, grading to blue-black of belly patch.

Range. Pyramid Lake, Nevada, southward through central and southern Nevada, southern Utah, northern Arizona, and in California in the Mohave and Colorado deserts, San Benito and Fresno Counties on the west side of the San Joaquin Valley, and south into extreme northeastern Baja California, Mexico.

Discussion. There is apparently little or no intergradation between *uniformis* and *magister* along the lower Colorado River, although some of the Imperial County specimens show some indication of the black stripe of *magister*. *S. m. uniformis* does intergrade with *S. m. magister* in southern Arizona (see Fig. 3).

Although the basic pattern of *uniformis* is the uniform light dorsum (Fig. 1), there may be on young males, and usually on females, a series of faint blotches, usually about 5 scale rows wide and 3 scales long. These occur also in about 10-20% of the adult males, but when present, they are always very dull (Fig. 1). Even when they are present as dull markings, they are not the shape of the blotches on the other races. These dull-marked individuals are especially common in extreme western Antelope Valley, California, and in southern Utah.

The subspecific name, *uniformis,* was chosen to indicate the uniform dorsal color of the male.

Referred Material (all in a strict sense paratypes). ARIZONA: Coconino County—Grand Falls, Little Colorado River (UCLA 139), Sedona (LMK 35876), Roaring Springs (SDSNH 13080, 13082, 13074, 13092, 13212), Cameron (LMK 25666-68), Indian Garden (LMK 35752), N. rim Grand Canyon, Power Plant (SDSNH 13065-67, 13070), Bright Angel (LMK 3168). Maricopa County—6 mi. S.E. Wickenburg (UI 27714-17), 9 mi. N. Gila Bend (SDSNH 14844-45), Peoria (UI 2460). Mohave County—Alamo Crossing (USCLA 2852), 26 mi. N. Chloride (LMK 10630-31), 6 mi. W. Wickings (SDSNH 17276), 4 mi. W. Wolfs Hole (SDSNH 17160), Pipe Springs (LMK 24885), Hackbery (LMK 31770), 4 mi. E. Grosman Peak (SDSNH 17165), Horse Peaks (SDSNH 17207-08). Navajo County—2 mi. N. Agatha Peak, Kayenta (MVZ 17864-65). Santa Cruz County—Tubac (SDSNH 14813, 14839). CALIFORNIA: Fresno County—Los Gatos Canyon (SU 633), Panoche Pass (MVZ 32900), 4 mi. W. Tranquility (MVZ 41015-18), Coalinga (CAS 13206), 4 mi. E. Coalinga (MVZ 18062), Kettleman Hills (MVZ 18061). Imperial County—Cargo Mts. (UCLA 3258), 3 mi. N. Baird (LMK 14053-54). Los Angeles County—Valyermo (UCLA 1812, TYPE; UCLA 1813), Lovejoy Springs (UCLA 136, 137; LMK 2831), Lovejoy Buttes (UCLA 1481, 4073-76; LMK 1936), Antelope Valley (LMK 733), Vasquez Rocks (UCLA 600), 5 mi. N. Llano (UCLA 5900-03), 3 mi. E. Palmdale (UCLA 3006), 5 mi. E. Lanomore (UI 30318). Riverside County—Indian Wells (UCLA 2404), Thousand Palms (UCLA 5609; LMK 7797), 4 mi. E. of Keys Ranch, Joshua Tree Nat. Pk. (LMK 28778), 6 mi. N. Whitewater (LMK 8522). San Benito County—3.8 mi. E. Panoche (MVZ 1605), 7.5 mi. S.E. Panoche (MVZ 24613). San Bernardino County—E. of Morongo Valley (USNM

44852), 7 mi. N.W. Adelanto (UCLA 2905), Adelanto (LMK 5726), Cottonwood Springs, Granite Mts. (UCLA 5198-99), 2.5 mi. N. Victorville (UCLA 4175), 2 mi. W. Rock Corral (LMK 31730), 7 mi. N. Red Mt. (LMK 28913), 2 mi. W. Warrens Well (LMK 31729), Yucca Station (LMK 7613). San Diego County—Borrego Valley (UCLA 2648), La Puerta Valley (Mason Valley) (LMK 28104; SDSNH 11381, 11383, 11385), Yaqui Well (LMK 22330). NEVADA: Clark County—Indian Springs Valley (USNM 18108-09), Bunkerville (USNM 18111), Callville, Colorado River (USNM 18104), Charleston Mts. (UCLA 1184-86), 7 mi. W. Searchlight (UCLA 5651), Las Vegas Valley (USNM 18107). Churchill County—Fallon (USNM 48691, 51901, 87025, 118461), 2 mi. N.W. Cave Springs (MVZ 10821), Fish Lake (MVZ 10818). Lincoln County—Pahranagat Valley (USNM 18096-102). Lyon County—22 mi. W. of Fallon (MVZ 20086-87). Mineral County—3 mi. S. Schurz (MVZ 17099). Nye County—6 mi. S. Pahrump (LMK 33766), Rhyolite (CAS 37516-17), Pahrump Valley (USNM 18103), Ash Meadows (USNM 18105-06). Washoe County—Wadsworth (LMK 27811; USNM 50833), Pyramid Lake (USNM 44785, 45201-06, 50808, 50810, 50831-32; UCLA 3430-32; LMK 38326, 36378, 38685). UTAH: Kane County—Kanab (LMK 24897-98, 24900, 24903, 24907, 24909-10, 24912, 24914). Washington County—5 mi. E. St. George (SU 8178), St. George (LMK 26666-68), Rockville (LMK 25664, 25598), 7.2 mi. W. Rockville (UI 27709), 2 mi. S. Springdale (UI 27710-11), Tower Lodge, Zion Nat. Pk. (UI 31651-52), Bloomington (LMK 26665). MEXICO, BAJA CALIFORNIA: El Mayor (LMK 10304; MVZ 9544), Los Palmitos, E. base Sierra Juarez (SDSNH 17053), Las Palmas Canyon (MVZ 10724), Volcano Lake (USNM 37659-60), Cocopah Mts. (USNM 37663), 7 mi. E. Cerro Prieto (MVZ 10755-56), San Felipe Bay (USNM 37664).

S. m. magister-uniformis intergrades are available from: ARIZONA: Maricopa County—5 mi. S.E. Wickenburg (UI 18099, 27712-13). Santa Cruz County—Tubac (SDSNH 14820).

The following specimens, mostly from the bottom of the Grand Canyon, probably represent a new subspecies (Lowe, ms.): ARIZONA: Coconino County—5 mi. S. Lee's Ferry (SDSNH 13055), 3 mi. S.W. Navaho Bridge (UI 27708), Uhkar Creek (UA, no number, 2 specimens), 11.2 mi. by U.S. Hwy. 89, E. of House Rock (MVZ 59390), Cameron (MVZ 17863). Mohave County—Lower end Toroweap Valley (MVZ 16393-95).

Sceloporus magister bimaculosus new subspecies

Type. U.C.L.A. 3816 collected by Richard G. Zweifel and Kenneth S. Norris on August 24, 1948.

Type Locality. 6.6 mi. E. of San Antonio, Socorro County, New Mexico.

Diagnosis. A *Sceloporus magister* characterized by the presence, in the adult male, of two parallel series of six or seven blotches, 1½ to 2 scales wide, on the dorsum from the neck to the base of the tail. Dorsal scales 31-34 (average 33.2), femoral pores 11-12 (average 12.6), usually with a well-defined dark stripe posterior to the eye.

Description of Type. An adult male, snout-vent length 104 mm., tail length 150 mm. Dorsal scales 33 from parietal to just posterior to thigh,

ventrals 38 from gular patch to femoral pores, scales around body 41, femoral pores 13-13, scales across the gular area from ear to ear 18, supraoculars 5-5, circumorbitals 5-7, fifth (last) supraocular touched by most posterior circumorbital, supralabials 4-4, infralabials 7-6, auricular lobules 5-5, lamellae of fourth hind toe 20-19.

Coloration (in alcohol): Ground color brown, top of head mottled with darker brown, borders of head scales with dark lines. A very pronounced posterior eye stripe, one scale wide, extending from eye to ear and on to uppermost auricular lobule. Shoulder patches well separated dorsally by 10 scale rows of light brown and bordered dorso-posteriorly by lighter than ground colored scales. Two series of dark brown blotches, six in each series, on back extending from just posterior to shoulder patch to base of tail. These blotches 1½-2 scales long and 1½-2 scales wide and separated by 1½ scales of lighter color. Blue-black gular patch present, confluent with shoulder patch through an area 5 scales wide. Belly patches relatively small, separate except for most anterior one-fourth; belly patches not touching gular patch or shoulder patch. Groin and small area of thigh with dark patch which is confluent with belly patch. Sides brown to bluish-brown which grades into belly patch near groin. Fifth toe on right hind foot entirely missing.

Range. Extreme southwestern Arizona, all of New Mexico, southwestern Texas, northern Chihuahua, and possibly northern Durango.

Discussion. Intergradation with both *S. m. magister* and *S. m. uniformis* probably occurs in southwestern Arizona, but we have seen only a few specimens which we consider intergrades. When more material is available, the forms in Texas and Durango may be found to differ sufficiently (4 rows of dorsal blotches instead of two) for subspecific recognition. The subspecific name, *bimaculosus,* is chosen in reference to the two rows of spots or blotches in dorsal pattern.

Referred Material. NEW MEXICO: Dona Ana County—Las Cruces (USNM 22269), Mesilla Valley (USNM 22382). Socorro County—7 mi. W. Socorro (UCLA 3815), Socorro (UCLA 3807-14, 3817; USNM 44592), 6.6 mi. E. of San Antonio (UCLA 3816, TYPE), 12 mi. N. Valverde, E. Bank Rio Grande (UCLA 3736). TEXAS: Brewster County—Boquillas (USNM 32939-40, 32942). El Paso County—El Paso (UI 21324, 1507; USNM 56860-62). MEXICO: CHIHUAHUA: Between El Paso and Janos (USNM 2964). DURANGO: Near Yermo (EHT 8334, in Smith, 1939). These are all, of course, paratypes.

S. m. magister-bimaculosus intergrades include: ARIZONA: Santa Cruz County—Santa Rita Mts. (CAS 63055, 48483).

We have seen no specimens which we consider *S. m. uniformis-bimaculosus* intergrades, although intergradation probably occurs in western Arizona.

Sceloporus magister transversus new subspecies

Type. UCLA 6695 collected by Robert L. Phelan on July 23, 1953.

Type Locality. Keough's Hot Springs, 7 mi. S. of Bishop, Inyo County, California.

Diagnosis. A *Sceloporus magister* characterized by the presence, in the adult male, and to some extent in the female also, of 6 to 7 dark crossbars on the back. These bars extend across the entire back and continue onto the sides and are usually 1½ scales wide. Shoulder patch usually

extends well up on the neck, nearly forming a collar. Ground color usually yellow. Dorsal scales 33-37 (average 35), femoral pores 11-12 (average 11.5).

Description of Type. An adult male, snout-vent length 101 mm., tail regenerated. Dorsal scales 35 from parietal to just posterior to thigh, ventrals 41 from gular patch to femoral pores, scales around body 38, femoral pores 14-12, scales across gular area from ear to ear 17, supraoculars 5-5, circumorbitals 6-6, fourth supraocular touched by most posterior circumorbital on each side, supralabials 5-5, infralabials 7-6, auricular lobes 5-4, lamellae of fourth hind toe 20-18.

Coloration: Ground color yellow, top of head strongly mottled with gray, tan, and dark brown; shoulder patches extending well up on neck, being separated dorsally by 2½ scales of lighter color. Dorsum from just posterior to shoulder patches to middle of tail with dark transverse cross-bars which extend across the back from one side to the other. These bars are separated from each other by 1½ to 2 scales which are lighter than ground color. Gular patch present, but small. Posterior portion of gular patch confluent with shoulder patch through an area 3½ scales wide; belly patches separate, although middle one-third of separation faintly blue; belly patches not touching shoulder patch or gular patch, but extending onto groin and thigh as small blotches.

Range. Inyo County, California, including Panamint and Argus Mountains, northern Kern County, and into the western parts of Mineral and Esmeralda Counties, Nevada.

Discussion. Intergradation with *S. m. uniformis* occurs in Kern County to the south and from Walker Lake, Nevada, through eastern Mineral and Esmeralda and western Nye Counties, Nevada, in the east.

The subspecific name, *transversus*, is chosen in reference to the transverse arrangement of the bars on the back of the lizards.

Referred Material (paratypes). CALIFORNIA: Kern County—11 mi. N. Randsburg (SDSNH 12241). Inyo County—Little Lake (UCLA 2649), 21.5 mi. N. Independence (UCLA 3083), Keough's Hot Springs, 7 mi. S. Bishop (UCLA 6695, TYPE; UCLA 6255), between Olanch and Cowan Station (SDSNH 12237), Keeler (LMK 34111), Bruce Canyon, Argus Mts. (CAS 65483), Mt. Springs Canyon, Argus Mts. (MVZ 35756), Panamint Mts. (MVZ 19249), Independence (MVZ 9460). NEVADA: Esmeralda County—Fish Lake (MVZ 10822-25). Mineral County—3 mi. S. Schurz (MVZ 17097-98).

S. m. uniformis-transversus intergrades include: CALIFORNIA: Kern County—Weldon (MVZ 2949, 2952, 2957, 2961-62), 11 mi. N. Randsburg (SDSNH 12241), 1 mi. N. Murdoc (UCLA 2798), Last Chance Canyon (UCLA 2647). Inyo County—Emigrant Pass (LMK 22228). Los Angeles County—Fairmont (UCLA 1364-66, 3021), 4 mi. W. Fairmont (UCLA 412). NEVADA: Nye County—1.6 mi. E. of California-Nevada border on road to Beaty, Nevada (UCLA 3038).

KEY TO THE SUBSPECIES OF *Sceloporus magister*

Since no consistent scutellation characteristics can be found in most cases, and since the color of the females and juveniles is not always diagnostic, this key can be applied effectively only to the adult males.

1. Dorsal pattern consisting of distinct longitudinal red, yellow, purple or black stripe or stripes..... 2

Dorsal pattern not of stripes, but of blotches, bars, or with no distinct pattern..... 5

2. Median dorsal stripe narrow, bordered broadly by red or rufous colored stripe on each side; no dark lines on lateral scales, femoral pores average 18 (15-20).....*S. m. rufidorsum*

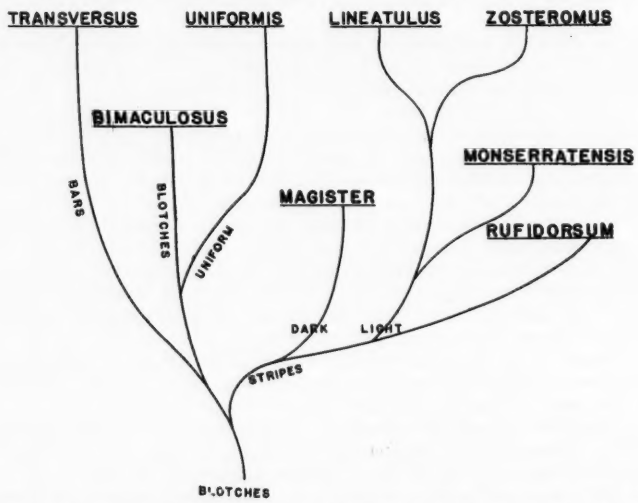

Figure 2. Suggested phylogenetic relationship of the races of *Sceloporus magister* based primarily on the basis of dorsal color pattern of the males.

Mid-dorsal stripe not bordered by red stripe, no red or rufous on dorsum, femoral pores usually above 15 or below 20..... 3

3. Mid-dorsal stripe dark (purple or black), 4½ to 5 scales wide, bordered laterally by light lines 1½-2 scales wide; femoral pores usually 13 (11-15).....*S. m. magister*
Mid-dorsal stripe light-colored, lighter than ground color, bordered laterally by darker lines, spots, or not conspicuously bordered; femoral pores usually 20 (16-24)..... 4

4. Mid-dorsal stripe 1-2 scales wide, bordered laterally by dark lines or series of spots.....*S. m. monserratensis*
Mid-dorsal stripe 5½-6½ scales wide, usually not bordered by dark lines.....*S. m. zosteromus*

5. Dorsal pattern of blotches or cross-bars..... 6
No well-defined dorsal pattern, back uniform in color..... 7

6. Dorsal pattern of two series of blotches from neck to tail, 6 or 7 blotches in each series.....*S. m. bimaculosus*
Dorsal pattern of 6-7 transverse cross-bars, crossing the entire back from side to side.....*S. m. transversus*

7. Ventral surface of humerus without dark markings; femoral

pores usually 12 (10-16); U. S. and northeastern Baja California.....*S. m. uniformis*

Ventral surface of humerus with dark patch which may cover entire ventral surface from shoulder to elbow, and which is usually confluent with shoulder patch; femoral pores usually more than 16 (17-20, average 19); Catalina Island, Gulf of California.....*S. m. lineatulus*

DISCUSSION

The differentiation of *Sceloporus magister* into genetically distinct races seems to be, as is the case in many of the forms in the genus, in a state of dynamic flux. Although the species has an extremely diverse and extensive distribution, regional or ecological specialization has reached

Figure 3. Distribution of the subspecies of *Sceloporus magister*.

only an early stage of development. The species ranges from extreme Lower Sonoran desert conditions in Mexico and southwestern United States to lower Transition Life Zones in the Colorado Plateau and northern Nevada. Despite this diversity of habitat, no great population differences exist within the group. As developed in this paper, only coloration differences can be correlated geographically with any degree of success. This might reasonably be expected to be the case in a form passing through the early stages of differentiation as color and pattern undoubtedly have a greater selective value than most scutellation characters. The importance of mating, aggressive, and territorial behavior in the differentiation of the male colors has been suggested. It is interesting to note that in the subspecies of *S. m. transversus, magister,* and *lineatulus* —the populations with the smallest ranges—the females, in general, approach the color pattern of the males.

The scale variations observed in the subspecies of *Sceloporus magister* are given in Tables I-III, and the basic patterns found are shown in Figure 1. Figure 2 shows the probable phylogeny of the group based primarily on color pattern, and Figure 3 gives the distribution of the known races.

SUMMARY

The basic differences observed in populations of *Sceloporus magister* are those of coloration of the adult males. Females and juvenile males tend to approach the male coloration in three of the recognized races (*magister, lineatulus,* and *transversus*). Scutellation characters (except femoral pores in a few cases) are so variable that they are not significant.

At present, the following races should be recognized (the last three are described herein): *Sceloporus magister magister, monserratensis, zosteromus, lineatulus, rufidorsum, bimaculosus, uniformis,* and *transversus.* With additional data, the forms in the Grand Canyon of Arizona, Texas and northern Durango, and on Tiburon Island, may be shown to be subspecifically distinct.

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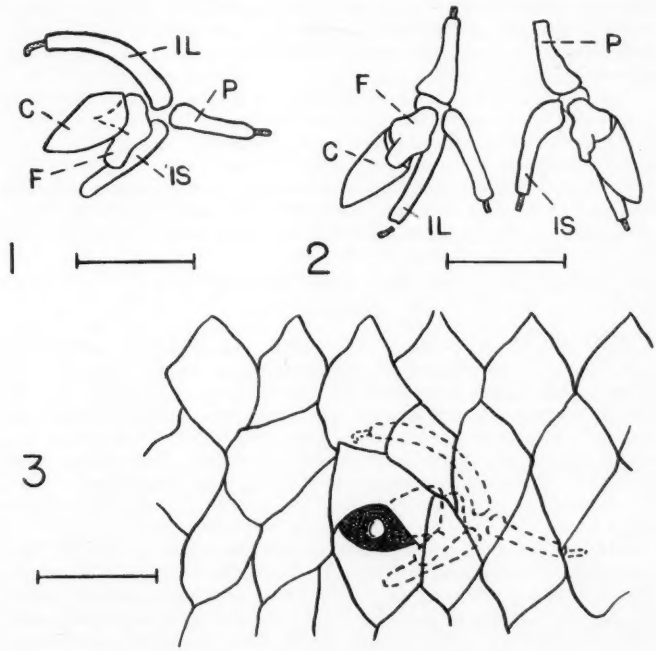
External Limb Vestiges in *Leptotyphlops*

By James C. List

The pelvic girdles of worm snakes of the genus *Leptotyphlops* are in most species rather well developed: paired ilia, ischia, and pubes are present, as well as a rudimentary femur on each side, usually capped by a claw-like structure (figs. 1 and 2). Ordinarily these bones and claws are embedded in the tissues of the body wall just anterior to the anus. However, in dissection of nearly 100 specimens of the African *L. nigricans* Schlegel, R. Essex (Proc. Zool. Soc. London, 1927: 879-927) noted some variation in the proximity of the claw to the skin, and in one specimen he found the claws projecting completely through the skin by way of a pair of perforations.



The scale equals one millimeter in each case. C, claw. F, femur. IL, ilium. IS, ischium. P, pubis. Fig. 1, pelvic vestiges, right side view. Fig. 2, pelvic vestiges, ventral view. Fig. 3, scales of pelvic region, right side.

In the course of study of a series of *Leptotyphlops* a somewhat similar condition has been noted in a specimen of *L. humilis cahuilae* Klauber from Laguna Dam, Imperial County, California, received through the kindness of Dr. J. R. Slevin. The snake (Univ. Ill. Mus. Nat. Hist. No. 35910) had been cleared in KOH and glycerine and the skeleton stained with alizarin before attention was drawn to a small mass of very fine sand apparently embedded in the skin on each side of the body in the pelvic region. On closer examination the sand was seen to partially fill a canal containing the claw, the tip of which rested just below the level of the epidermis.

In the *L. nigricans* reported by Essex the perforations in the skin are shown (*op. cit.*, fig. 39, D) to have the form of a scale, as if a complete scale were absent on each side. In the present specimen the scales in that immediate area are irregular in shape and the pore is surrounded by a pair of scales (fig. 3).

The *L. nigricans* was an adult male with fully developed testes. Essex considered this significant and suggested the possibility that "the claw may protrude only at the breeding season, being used for copulation," presumably as are the spurs of boas and pythons in courtship. And "If this be so, it will account for very few specimens taken with protruding claws."

The *L. h. cahuilae*, however, is not only a female but its length of 215 mm. is considerably less than that of mature (egg-laying) females of the species. Moreover, it seems unlikely that periodic appearance and withdrawal would alone account for the extreme rarity of such external claws. Unless further study shows them to be more common it would seem best to consider these protruding claws of worm snakes as simply an atavistic variation persisting from ancestral stages in which they were normally better developed.

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THE GENERIC NAME OF THE ALLIGATOR SNAPPER TURTLE.—All six editions of the checklists of North American amphibians and reptiles have used the generic name *Macrochelys* for the alligator snapper, correctly citing Gray, 1856 (Jan. 22 fide Stejneger and Barbour, Checklist N. Amer. Amph. Rept., 1917:113) (Proc. Zool. Soc. London, 1855:200) as the original source. Actually Gray proposed the name *Macroclemys* for this genus a year earlier (Cat. Shield Rept., 1855: 48), as noted by William (Breviora, No. 2: 5, 12, 1952) in connection with a synopsis of fossil forms of the Chelydridae.

The year of publication of the names *Macroclemys* (1855) and *Macrochelys* (1856) is agreed upon by Boulenger (Cat. Chel., Rhynch., Croc. Brit. Mus., 1889: iii, 23) and the two most recent generic indices (Neave, 1940, Nomencl. Zool., 3: 10, 11; Schulze *et al*, 1932, Nomencl. Anim., 3: 1936-7). Application of the Law of Priority accordingly requires usage of *Macroclemys*, the earlier name, for this genus. Request for suspension of the rules does not seem warranted in view of the similarity of the two names. The living species should thus be known as *Macroclemys temmincki* (Troost).—Hobart M. Smith, Dept. Zoology, Univ. Illinois, Urbana, Illinois.

Comments on the Distribution of Certain Mexican Toads

By WILLIAM J. RIEMER

The following paragraphs present information on the distribution of several species of Mexican toads. The majority of the specimens upon which the comments are based were collected by Richard Zweifel and me on a trip made possible by funds received from the Martha Gerbode Donation in memory of Annie M. Alexander and from the Revolving Research Fund of the American Society of Ichthyologists and Herpetologists.

Specimen numbers listed in the text, in every instance, are those of the Museum of Vertebrate Zoology, University of California.

Bufo alvarius Girard

The southernmost record of this species known to me is that reported by Bogert and Oliver (1945: 339) as Guirocoba in southeastern Sonora. A single male of this species (58724) was collected by Zweifel, 18 July 1953, 7 miles W. Guamúchil (about 70 miles N.W. Culiacán), Sinaloa. This extends the known range a little more than 100 miles southward. It is probable that the species exists even farther southward on the coastal plain into central or southern Sinaloa.

The animal was taken at dusk on a dirt road that traversed arid thorn forest. The surface soil was dry but rains had fallen a day or two previously. *Bufo mazatlanensis* was taken at the same place. The animal is presumably subadult, having a snout-vent length of 82 mm.

Additional individuals were collected in Sonora on 19 July 1953, two from 1½ miles E. Bacum and a third from 10 miles E. Vicam. All three were taken on the highway at night following a rain.

Bufo cognatus Say

Savage (1954b: 326) reports a single individual collected 10 miles southeast of Pitahaya, Sonora, a southward extension of range along the coastal plain of several hundred miles. A female (58762) with a snout-vent length of 59 mm. was collected by me on 19 July 1953, 4.4 miles north of Ciudad Obregon, Sonora. This example extends the range an additional 30 miles east-southeast, but more importantly substantiates the natural occurrence of the species in southern Sonora. The animal contains ova which are heavily pigmented and slightly less than 1 mm. in diameter.

Additional individuals of this species have been collected in Durango, 4 miles W. San Juan del Río, 5800 feet (58753-58754); 18-22 miles N. Durango, 6300 feet (58755-58756, 58760); 8 miles E. Canatlán, 6300 feet (58757-58759); 1½ miles N. Morcillo, 6300 feet (58761); and in San Luis Potosí, Potrero Santa Ana, 7.6 miles S. Matehuala (36675-36677); and 5 miles N. San Luis Potosí (36678). All the Durango toads were taken on 6 July 1953 during and between night-time showers. Chorusing was in progress.

Bufo debilis Girard

In 1951 Sanders and Smith reviewed the *debilis*-like toads and concluded that the three species *debilis, insidior* and *kelloggi* were all subspecies of one another. They erected a fourth subspecies, *retiformis,* which was then known from a single specimen from southwestern Arizona.

More recently Savage (1954a: 105) reports *retiformis* from north-

western Sonora. Because of the distinctness of *retiformis* from *kelloggi* he has concluded that these forms, *i.e., debilis* and *kelloggi,* are genuine species.

On 19 July 1953 Zweifel and I collected a series of eight adult toads (58787-58794), 11 miles N.W. Vicam in southern Sonora. These toads come from a spot roughly midway between areas known to be inhabited by *retiformis* (northwestern Sonora) and *kelloggi* (southern Sinaloa). In many of their diagnostic characters they are also intermediate between these two forms. This find corroborates the assumption of Sanders and Smith that *kelloggi* is indeed merely a race of *debilis.*

It is worth emphasizing here that geographic variation in color and pattern between the races *debilis* and *insidior* and between *insidior* and *retiformis* are of the same magnitude as those between *retiformis* and *kelloggi.* In addition there is a pronounced difference in spinosity between the last two races. Considering this great range in variation, it cannot be said to be presumptuous on the part of Sanders and Smith to consider *kelloggi* as a member of the species *debilis.* It is also possible, after examining *kelloggi* and *retiformis* and recognizing the lack of intermediate material available to Savage, to appreciate his contentions.

A comparison of the races *retiformis* and *kelloggi* and the intergrades from southern Sonora is presented below. The letters K, R, and I stand for *kelloggi, retiformis* and intergrades respectively.

Parotoid gland: K. Large, but not prominent, greatest width near anterior end, often quite narrowed posteriorly by an indentation of the mesial margin. R. Large, prominent, mesial margin not indented. I. Similar to *kelloggi* both in shape and prominence.

Cranial crests (supra-, pre-, post-, and suborbital): K. Prominent, surmounted by high, sharp-pointed tubercles forming a continuous row. R. Reduced or absent, usually consisting of a discontinuous series of small tubercles or merely a few scattered ones. I. Intermediate, less spinose than *kelloggi* but crests essentially continuous.

Suborbital crest: K. A row of prominent spines. Anterior to the preorbital crest it is present as the upper margin of a subloreal-subnasal tubercular field. R. Almost completely absent except for a few disjunct tubercles. I. Prominent as a ridge with poorly developed spines forward to a spot midway between the preorbital crest and the nostril. From there it continues to the nostril as a series of disjunct tubercles. The subloreal-subnasal field of tubercles is relatively poorly developed.

Tubercles on the dorsal surface of the body: K. Everywhere abundant, prominent, sharp-pointed and giving the animal a quite spiny appearance. (Savage uses the term "diffuse" in describing the tubercles on the parotoid glands.) R. Greatly reduced, broad and low, few in number, each with a minute black tip. I. Intermediate, not spinose as in *kelloggi,* but tubercles much more numerous and better developed than in *retiformis.* Relatively few are dark-tipped, most being quite blunt or rounded.

Inner palmar tubercle: K. Usually slightly smaller than subarticular tubercles. R. Larger than subarticulars. I. Similar to *kelloggi,* being no larger than subarticulars.

Pectoral region: K. With scattered darkish spots. R. Immaculate except for a characteristic pair of lateral pectoral spots. I. As in *retiformis.*

Dorsal pattern (in life): K. Of irregular, blackish-brown, vermiform markings on a yellowish-brown ground color. A light line from the parotoid to the groin. R. Of large, green, ovate blotches surrounded by a coarse, black reticulum. I. Of pinkish-tan ground color with a broken, irregular network of dark olive-green to deep brownish-black. A light line from parotoid to groin present and in most cases quiet distinct. Pattern intermediate and similar to that shown in Taylor ("1936": 535, Plate 45, figure 1).

Savage, just prior to the appearance of his paper, kindly examined the intergrades reported here and quickly admitted the intermediacy of their characters.

There has a been a considerable difference of opinion expressed in these two reviews of the *debilis* group in regard to the origin and phylogenetic history of the members. Savage postulates (1954a:109) a *valliceps*-like progenitor of the group. This ancestral stock arose in the mysterious regions of central Mexico and as it began its "northward migration" a segment broke off along the west coast and became isolated, later becoming the species *kelloggi. Kelloggi* is claimed to be the form most closely allied to the ancestral stock. Soon the race *debilis* became differentiated along the eastern Mexican coast while the *insidior-retiformis* precursors moved still farther northward. As a final step *retiformis* differentiated in the northwesternmost portion of the range of *insidior.*

Sanders and Smith (p. 157) examined skeletons of many species of toads and concluded that a similarity exists between the skulls of the species *debilis* and the species *punctatus.* Evidence of relationship, however, is too obscure, they feel, to make any statement on the origin of the group. They name *insidior* as the most primitive (in contrast to Savage) and speculate that the other three races are probably derived from it.

It is evident that except for the inconclusive evidence derived from the examination of skeletal parts by Sanders and Smith, no information is available on the phylogenetic origin of the species *debilis.* Even less information is available on the geographic origin of the group. Finally, there is no basis in fact for picking any one race of this species as being most primitive and deriving the others from it. It is quite satisfactory, considering the present state of our knowledge, to suggest that the phylogenetic relationships can best be portrayed with the following diagram.

kelloggi——retiformis——insidior——debilis

Arrows are not used since we do not know in which direction or from what point evolution took place.

The intergrading toads discussed here were collected at night along the margins of large rain pools next to the highway. Amplexus was taking place. Males were calling with a medium-strength, medium-pitched, bee-like buzz quite reminiscent of *Microhyla carolinensis.* Also like that of *Microhyla,* the call is ventriloquial. *Pternohyla fodiens* was abundant in the same pools.

Bufo mazatlanensis Taylor

Following the original description of *mazatlanensis* by Taylor (1939: 492) from specimens secured near Mazatlán, Bogert and Oliver (1945: 341) reported the species from southern Sonora. Since that time the species has been collected at several points scattered through the southern

quarter of Sonora, but not from the 300-mile-long region which separates southern Sonora from the type locality.

On 18 July 1953 Zweifel collected three examples of this species 7 miles W. Guamúchil (about 70 miles N.W. Culiacán), Sinaloa. This locality lies almost midway between the areas from which the toad was formerly known. There was, of course, little reason to doubt the existence of the species in northern and central Sinaloa despite the lack of collection records.

Of the three toads collected (58749-58751), one is a female with a snout-vent length of 81 mm. and with ovaries enlarged with ova of about 1 mm. in diameter. None appears to be present in the prominent oviducts. The other two are males of 56 and 72 mm. Each has nuptial callosities on the two innermost fingers of each hand, those of the larger male being better developed. He has, in addition, similar dark pigment on the large inner palmar tubercle and along the inner edge of the third finger.

Another specimen (58752) was collected by Zweifel 6.3 miles E. Bacum, Sonora. Savage (1954b: 326) has a record for very nearly the same place, *i.e.*, 5.4 miles W. Corral. The animal from near Bacum is a male of 62 mm. and has well-developed nuptial callosities on the three innermost fingers and on the inner palmar tubercle.

An additional series of nine specimens (58740-58748) was collected between 5 and 11 miles N. Mazatlán, Sinaloa.

Bufo microscaphus Cope

This toad is unrecorded from Mexico except for the race *californicus* which is known only from northwestern Baja California Norte. Stebbins (1951: 266-267) writes: "Individuals of uncertain affinity but showing *microscaphus* characters . . . have been found in the following localities outside the range given . . . Rio Gavilan, 7 miles southwest of Pacheco, at 5700 feet; and Meadow Valley, 5 miles south of Garcia, at 7500 feet (both localities in northwest) Chihuahua. . . . " These specimens have been re-examined and determined to be, indeed, *microscaphus*.

During June and July of 1953 Zweifel and I collected individuals of this species in southwestern Chihuahua at 7 miles S.W. El Vergel (=Lagunita), 7800 feet, and in southwestern Durango at 6 miles W.S.W. Las Adjuntas, 8500 feet. The Durango locality extends the range about 850 miles southeast of the southernmost station from which *microscaphus* was definitely known previously, *i.e.*, the vicinity of Phoenix, Arizona.

The toads were collected at both localities in pine-oak forest in the vicinity of small streams. In Chihuahua the heavy summer rains had not yet begun by 2 July. The animals there were collected between 29 June and 2 July. Exposed soil away from the stream was dry and dusty. The stream, only a few feet wide, and essentially a series of shallow pools, was clear. Only a tinge of green represented the sparse young grass on a meadow adjacent to the stream. A series of eighteen adults and subadults (58763-58780) was collected. Larvae were abundant in the stream and newly metamorphosed young (58783-58785) were everywhere on the damp soil near the water and were occasionally seen several hundred yards from the stream up the dry slopes in the forest. None of the adults was heard to call.

In Durango one adult and one subadult (58781-58782) were collected on 11 July 1953. No larvae or postlarval young were found. Here summer rains were in progress for at least two weeks prior to this date.

Shannon (1949) has considered *microscaphus* a race of *woodhousei* and has presented data to show the essentially allopatric nature of their geographic ranges. Stebbins (1951) considers *woodhousei* and *microscaphus* to be distinct species which show hybridization in some areas of contact.

Collection of *microscaphus* in the Sierra Madre Occidental places it in the position of extensive geographic overlap with *woodhousei*. It is primarily for this reason that I have chosen to follow Stebbins in considering *microscaphus* a species. It now becomes of interest to re-examine the specimens of *Bufo* previously collected in the mountains of western Mexico and usually assigned to the species *woodhousei* or *compactilis*. A detailed study is now underway on the geographic relationships of the species *woodhousei, microscaphus* and *compactilis* in the southwestern United States and in Mexico.

Bufo occidentalis Camerano

On 9 August 1948 two individuals were collected by Ward Russell at the Rio Gavilán, 7 miles S.W. Pacheco, 5700 feet, in northwest Chihuahua. One (46639) is a female of 85 mm., the ovaries of which are filled with eggs of one-half mm. or less in diameter and which are intensely, and almost totally, black. The other (46640) is apparently a juvenile female of 49 mm.

The nearest localities from which the toads have been previously reported are as follows: Sinaloa—Mazatlan, Presidio and Plomosas. Durango—(Milpas). Zacatecas—Sierra Madre (all in Kellogg 1932: 64 and 67). San Luis Potosi—Cañada Grande (Taylor 1952: 801), Pozo del Carmen (Taylor 1953: 1591). Chihuahua—no specific locality given (Taylor and Knobloch 1940: 125). The locality in parenthesis represents a collection made during the previous century and I have not been able to locate it on available maps. Indeed, it may not represent the name of a town.

It is known that some of the material collected by Knobloch in Chihuahua came from Mojárachic in the southwestern portion of that state. It is possible that the *B. occidentalis* also came from here. If this inference is true the toads reported on here extend the range more than 150 miles northward. It is possible that eventually the species may be found to extend as far north as southwestern New Mexico or southeastern Arizona.

The specimens from the Rio Gavilan display in preservation an olive-gray dorsum overlain with irregular black or dark gray spots and blotches. In the smaller individual the dark pigment tends to form a discontinuous reticulum in places. There is no sign of a vertebral stripe.

There are also in the collections of the Museum of Vertebrate Zoology toads of this species from El Batel, 70 kilometers N.E. Mazatlan, 5100 feet, Sinaloa (44692); from Atenquique (56269-56271) and from Rancho "El Rodeo," Sierra de Ixtlán, near San Marcos (56267-56268), Jalisco.

Usually recognized in the literature as *Bufo simus, B. monksiae* or

B. occidentalis, I have chosen to follow, in part, the arguments of Firschein (1950) and refer to the species as *B. occidentalis.*

Bufo punctatus Baird and Girard

This toad occurs widely over the Mexican plateau and adjacent coastal areas. Heretofore, it has been unrecorded from Durango. In that state on 21 July 1952 Robert Selander collected a single individual (57391) 35 miles S. El Entronque, 5000 feet. On 6 July 1953 Zweifel collected two (58737-58738) 16 miles N. the city of Durango and I collected one (58739) 1½ miles N. Morcillo, 6300 feet. All three taken on 6 July were collected on the pavement at night following a heavy rain. The individuals mentioned are all large adult females. The two from 16 miles N. Durango contain ovarian eggs the largest of which are 0.7-1.0 mm. in diameter. Fewer than half of these are pigmented. The individual from near El Entronque and the one from near Morcillo each contain ovarian eggs almost all of which are pigmented, the largest being 1.0-1.4 mm. in diameter. The rain on 6 July was apparently one of the first of the season and from the condition of the ovarian eggs it is probable that this species begins breeding in central Durango from the middle of July to early August shortly following the onset of the summer rains.

Specimens in the Museum of Vertebrate Zoology provide two additional localities for this species in Chihuahua, a state from which there are few previous records. One adult male (58736) is recorded from Hidalgo del Parral, 5500 feet, 27 June 1953, and a series of seven juveniles (52167-52173) from 24.6 miles S. Villa Ahumada, 3800 feet, 22 August 1949. The adult male has nuptial callosities on the two inner fingers of each hand. In life its dorsum was a uniform grayish-brown with numerous red-tipped tubercles. The venter was marked with small, black, irregular rings.

Known from as far south on the plateau as central Guanajuato, this species is to be expected to occur in the states of Jalisco, Aquascalientes, and Zacatecas.

Because certain of the localities given in the preceding text are difficult or impossible to locate on most maps the following data are furnished.

Chihuahua: El Vergel (=Lagunita) 26° 7′ N, 106° 34′ W. Garcia 29° 59′ N, 108° 20′ W. Mojárachic 27° 53′ N, 107° 45′ W. Pacheco 30° 6′ N, 108° 21′ W. Villa Ahumada 30° 37′ N, 106° 33′ W.

Durango: Canatlan 24° 32′ N, 104° 45′ W. El Entronque 25° 50′ N, 104° 42′ W. Las Adjuntas 23° 43′ N, 105° 34′ W. Morcillo 24° 10′ N, 104° 40′ W. San Juan del Río 24° 47′ N, 104° 27′ W.

Jalisco: Atenquique 19° 30′ N, 103° 30′ W. San Marcos 20° 48′ N, 104° 12′ W.

Sinaloa: El Batel 23° 31′ N, 105° 53′ W. Guamúchil 25° 27′ N, 108° 5′ W. Plomosas 23° 5′ N, 105° 27′ W. Presidio (?). Said to be 50 miles S. Mazatlan (Taylor "1936": 505).

Sonora: Bacum 27° 31′ N, 110° 5′ W. Corral 27° 36′ N, 110° 1′ W. Guirocoba 26° 54′ N, 108° 40′ W. Pitahaya 27° 48′ N, 110° 25′ W. Vicam 27° 35′ N, 110° 17′ W.

Zacatecas: Sierra Madre 22° 58′ N, 104° 00′ W.

I am indebted to C. M. Bogert and R. G. Zweifel for providing the probable location of Mojárachic, Chihuahua. This is an important type locality which appears on no known map, has never been defined by those using it, and has long been a thorn in the side of herpetologists.

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MUSEUM OF VERTEBRATE ZOOLOGY,
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NEW LOCALITY RECORDS FOR THE LOUISIANA PINE SNAKE, *PITUOPHIS CATENIFER RUTHVENI* STULL.—The Louisiana Pine Snake, described by Stull in 1929 as *Pituophis melanoleucus ruthveni* (Occ. Pap. Mus. Zool. Univ. Michigan, No. 205, pp. 1-3), is exceptionally rare in collections. For Louisiana, published records are those of the holotype and paratype from Longleaf, Rapides Parish, and a third from Hodge, Jackson Parish (Clark, Journ. Tennessee Acad. Sci., Vol. 24, 1949, p. 251). Smith and Kennedy (Herpetologica, Vol. 7, 1951, pp. 93-96) have referred to this subspecies three specimens from Polk, Nacogdoches and Angelina counties of eastern Texas. These specimens extend the known range of *ruthveni* approximately 125 miles from the type locality, and seem to demonstrate intergradation with the bull snake, *Pituophis catenifer sayi* (Schlegel).

From western Louisiana, four additional specimens are known from four localities that are geographically intermediate between localities of occurrence previously known from Louisiana and eastern Texas. Thus, there are ten recorded specimens of the subspecies. So far as known, all were obtained in an upland habitat characterized by sandy soil, heavy rainfall, and in an open type of forest dominated by longleaf pine (Smith and Kennedy, *op. cit.*).

Dr. Henry S. Fitch has given me records of three specimens collected by him. One was found DOR ten miles southeast of Leesville, Vernon Parish. The other two specimens were collected alive in April and May, 1948, in the Red Dirt Refuge, Natchitoches Parish, seven miles south of Cypress and ten miles south southwest of Cypress. In May, 1953, a live specimen was received by Dr. George H. Lowery. It was captured five miles east of Bellwood, Natchitoches Parish.

The data recorded from the Louisana State University specimen are as follows: scale rows, 28-29-19; ventrals, 220; caudals, 63 plus; supralabials, 9-9; infralabials, 13-13. The length of the rostral, stated by Stull as one of the best distinguishing characters of *ruthveni,* was damaged beyond recognition while the snake was in captivity. The supralabials were also damaged. The specimen is placed in the subspecies *ruthveni* on the basis of the scale count in front of the anus, the divided blotches, and the general coloration of the body and tail. There are thirty-eight dorsal blotches; they are separated by one scale row anteriorly, are partly divided on the anterior one-third, and are progressively paler on the posterior two-thirds of the body and tail. Those blotches on the posterior part of the body and tail are reddish-brown, paler than anteriorly.

Smith and Kennedy thought that the specimens of *Pituophis melanoleucus ruthveni* from eastern Texas probably would show intergradation with the bull snake, *Pituophis catenifer sayi* (Schlegel), and therefore concluded that *Pituophis catenifer* and *Pituophis melanoleucus* are conspecific. The subspecies *ruthveni* is separated from the western subspecies of the pine snake, *Pituophis melanoleucus lodingi* Blanchard, by a distance of more than 250 miles. Actually both *Pituophis catenifer ruthveni* and *Pituophis melanoleucus lodingi* occur among the longleaf pines and are unknown in the intervening area of hardwood forests and the broad floodplain of the Mississippi River separating the geographic ranges of the two species. I doubt that intergradation occurs between the two. Therefore, it seems a reasonable conjecture that *ruthveni* is a subspecies of *catenifer* and not a subspecies of *melanoleucus,* and that *Pituophis catenifer* and *Pituophis melanoleucus* are distinct species.—Charles M. Fugler, Museum of Natural History, University of Kansas, Lawrence, Kansas.

The Amphibia of Cherokee County, Oklahoma[1]

By ARTHUR N. BRAGG[2]

Cherokee County is located somewhat to the south of the northeastern corner of Oklahoma, in the third tier of counties south of Kansas and the second west of Arkansas. The Grand River was its natural boundary on the west but this now has become the Fort Gibson Reservoir for much of the distance along this border. In its eastern part Cherokee County is drained by the clear-water, fast-flowing Illinois River which, entering near its northeastern corner, flows through the county going just west of south and leaves it just east of its southwestern corner. This river has also recently been dammed to form the Tenkiller Reservoir in southern Cherokee County, still not full for the first time, at this writing (July, 1954).

The county is rough physiographically because located in a portion of the Ozarks. Human settlements are mostly small with tiny farms along the valleys of the major creeks and rivers. A few small areas of tallgrass prairie also occur, essentially as "islands" in the oak-hickory or oak-hickory-pine woodland. Springs are very frequently present, especially in stream valleys, their runs making an ideal environment for the larvae of certain species of salamanders. There are several larger or smaller caves here also which give other species a proper habitat.

Twenty-nine fairly clearly distinguishable forms of amphibia have been collected within the county, about half of them Salientia, the remainder, Caudata. I have personally collected examples of all except six of these during the past ten years, and have heard the call of one salientian later reported here from specimens by Blair (1950). The University of Oklahoma Museum has examples of most of the forms mentioned, some collected by me, many by others. Among others, biologists especially familiar with this region of Oklahoma are Dr. A. P. Blair of Tulsa, Dr. Charles C. Smith of Pawhuska, Dr. George Moore of Stillwater, and Mr. Harold A. Dundee, now a student at the University of Michigan. I am somewhat indebted to all of these for some of my understanding of the amphibians discussed below, especially to Mr. Dundee who as my assistant in the Oklahoma Biological Survey (as well as independently of me) has collected specimens all over the area, especially of the lesser known salamanders. An annotated list of forms is presented below:

Caudata

1. *Ambystoma annulatum* Cope. Known only as recently reported by Firschein and Miller (1951).

2. *A. maculatum* Shaw. I have collected specimens of this species in two widely separated areas of the county and its egg jelly from which larvae had just hatched in a third. It is almost certainly county-wide in distribution but found only in the wooded valleys of streams, breeding in small ponds and sprawled out pools in streams. Eggs and embryos have usually been present in such pools when visited in March but not in February even of years of warm winters. During breeding periods adults

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may be found resting beneath objects such as flat stones or logs near breeding sites during daytime, even when embryos fairly well along are in the pools. Presumably, therefore, the breeding period lasts for two or more weeks throughout which egg-laying occurs during at least some nights.

3. *A. texanum* Matthes. Common in wooded areas.

4. *Diemictylus viridescens louisianensis* (Wolterstorff). The Louisiana newt is very abundant in at least one region of Cherokee County. This is on top of a high wooded hill on the bluff above Barron Fork Creek, on Highway 62 just less than 4 miles east of the junction of this with Highway 51 at Eldon. Here in a rather large but shallow pool, Mr. Dundee and I have found larvae several years ago. Since then I have seldom failed to find adults, larvae or both, on springtime visits to the site. At one time in April I watched the mating behavior of specimens of this subspecies here including the attempt of as many as three males simultaneously to clasp a single female. On February 12, 1954, there was but little water here and no salamanders were in this. Beneath a small log in the pool's basin, however, twenty-three newts were resting along with several frogs and one other salamander. Larvae were also once found in a pool near the southeastern border of the county, not over ten miles from the other site.

5. *Eurycea griseogaster* Moore and Hughes.

6. *E. multiplicata* Cope. Some herpetologists (e.g. Schmidt, 1953) are now considering these two salamanders as subspecies which, indeed, they may be. Both occur in Cherokee County but apparently they tend to occupy different habitats. Wherever very small streams traverse limestone rocks or soil, *E. multiplicata* is very likely to be present. If a similar stream cuts through chert, flint, or granite, *E. griseogaster* is the form to be expected, if either form occurs. My experience is not wide enough to say that there never are exceptions, but I can say that so far I have found none in Oklahoma.

A recent experience is of interest here. I had collected a dozen or so specimens of *E. multiplicata* and, wishing to retain them alive, I prepared a terrarium for them. The bottom was covered with about one inch of fine white sand and a generous quantity of peat moss placed in one end. The whole was well moistened and the salamanders introduced. In the container with the animals I had included a handful of soil from their habitat and this was molded into a roughly ball-like mass and put into the terrarium opposite the peat moss. Two days later, I found no salamanders in the moist peat moss. Every one of them was coiled on top of the dark ball of drying limestone loam from their original habitat. Several days later all were found dead and thoroughly dried out on this ball of now dry earth; but the peat moss still had moisture. The exact reason for their behavior was not determined; apparently, their reluctance to leave the soil of their habitat was very great but this may have been due to an aversion to crossing the sand rather than to active preference for the limestone soil.

In Cherokee County, my experience with *E. griseogaster* has been interesting and thought-provoking but somewhat exasperating as well. All along the western bank of the Illinois River in northeastern Cherokee County, several small, spring-fed streams have cut valleys (some of them very steep-sided) through the bluffs facing the river.

One of these whose mouth at the Illinois is located about one-half mile south of Peavine Creek a few miles from the post office at Scraper, Oklahoma, is apparently unnamed. Because of its smaller size and close proximity to the larger stream, I call it Little Peavine Creek. Here the valley is very steep sided and the stream bed filled with gravel and stones. Water comes to the surface only here and there but mostly flows beneath the surface of the gravel. One larger and several smaller springs, the latter of intermittent flow, open directly to the stream at its bank. I am told by a resident here that in time of heavy rain this stream can have a large flow temporarily.

Particularly in the gravel below the springs, larvae of *E. griseogaster* have nearly always occurred whenever I have searched thoroughly for them from early February through June. I have not found them in July on two occasions and I have not been here during the period of August through January at any time. I first found these larvae in June of 1945 when they were lying in the open on ledges covered by not more than one-half inch to three inches of water. They were quite small, and I found them difficult to capture because at the slightest disturbance they scooted quickly for cover. I later determined that young larvae of this species lie thus in the open both night and day, when Harold Dundee and I camped for several days here. As the larvae approach three-fourths inch in length, they spend less time in the open and more hidden in the gravel. When ready for metamorphosis, they leave the stream and finish their development in moist leaves and beneath stones very close to its bank. These statements are made on the basis of only three specimens, one found in such a situation at Little Peavine Creek on each of three occasions.

Another thing of interest is that at all seasons when large larvae occur in this creek, small ones also have been found. This suggests the lack of a clear-cut breeding season for the form, small groups breeding whenever they are physiologically ready throughout a large part of the year. An alternative, of course, is that the animals spend a long period in the larval stage so that larval generations overlap. I have searched to no avail for data tending to show which is correct. I have also failed in nine years of intermittent observation to learn when, how, and where these animals breed, and I have not yet been able to find their eggs. Incidentally, this is also true of the better known *E. multiplicata* whose habitats I have also searched for ten or more years, in Cherokee as well as in other counties in eastern Oklahoma.

7. *E. longicauda melanopleura* (Cope). Common in caves.

8. *E. lucifuga* (Raf.). Common at larger springs, especially in creek valleys where it hides in the wet moss and other vegetation.

9. *E. tynerensis* Moore and Hughes. Both Dr. George Moore (one of the describers of this species) and Mr. Dundee have told me that this form occurs in Peavine Creek. I have collected it in Cherokee County.

10. *Necturus maculosus maculosus* (Raf.). This salamander occurs in both the Grand River and the Illinois although I have never taken it myself. Natives along the latter have described it very accurately in telling of catching it while fishing.

11. *Plethodon cinereus angusticlavius* Grobman.

12. *P. c. serratus* Grobman. One normally expects the former of this

pair to occur in Cherokee County and the latter to occupy the Ouachita mountains to the south of the Arkansas River (Grobman, 1944). In the area on the hill-top discussed in connection with the newts one specimen of each of these forms has been taken, *P. c. serratus* by Mr. Frank Hudson (Bragg & Hudson, 1951), and the other by me. Each showed perfectly the subspecies characters. Since examples resembling each form can occur in a single population, one could hold (a) that these should not be considered as subspecies but only variants of one form, (b) that we must give up the geographic criterion for a subspecies, (c) that the population sampled is intergradient, or (d) that variants resembling one form may occur with a certain frequency in populations of the other form. I await more specimens from this population before commenting further.

13. *Plethodon glutinosus glutinosus* (Green). Fairly abundant in heavily wooded valleys beneath leaves and other objects, especially on hillsides above streams, large or small. A few have been taken, for example, at Little Peavine Creek.

14. *Typhlotriton spelaeus* Stejneger. The larvae are common in springs and spring runs. I have not found adults in Cherokee County. Indeed, they have been taken only once, so far as I know, in Oklahoma (Blair, 1951).

Salientia

1. *Acris crepitans* Baird. Abundant on muddy banks of streams and pools, rare or absent along heavily graveled streams or in deep woods.

2. *Bufo terrestris charlesmithi* Bragg. Very abundant in the wooded and hilly sectors especially where it breeds in very small flowing streams as well as in shallow pools. Less common in the valleys than on the hillsides, (Bragg, 1950).

3. *Bufo woodhousei fowleri* Hinckley.

4. *B. w. fowleri* x *B. w. velatus* Bragg and Sanders.

5. *B. w. woodhousei* Girard. Cherokee County is one meeting place of the three forms of Bufo listed. In northern Cherokee County, especially along the Illinois River, typical *B. w. fowleri* occurs. A single specimen of *B. w. woodhousei* has been taken in the central part of the county, also along this river (Bragg, 1951). In the southern portion of the county, toads of this group clearly show the influence of *B. w. velatus* although they are more *fowleri*-like than *velatus*-like. Cherokee and adjacent Adair Counties, therefore, may be taken as the zone of junction and intergradation among these toads. Just how *B. w. woodhousei* fits into the picture here is unknown but probably its characters blend in with one or both of the other two here as I know them to do farther south in the state.

6. *Hyla crucifer crucifer* Wied. The spring peeper is known to me here primarily from two breeding congresses heard during one afternoon in 1949. One was on Highway 51 just south of Highway 62 at Eldon, in the valley of Barron Fork Creek, the second, in the pool on the hill above this stream mentioned earlier as harboring newts. I recorded their calls and later collected tadpoles in each place but took no adult specimens. This little frog is now known throughout eastern Oklahoma.

7. *Hyla versicolor versicolor* Le Conte. Very abundant in all wooded sections.

8. *Microhyla carolinensis carolinensis* (Holbrook).

9. *M. c olivacea* (Hallowell). Whether one considers these as species or subspecies, both forms occur in the county. I have seen the former several times and heard the call of the latter. Blair (1950) reports that their ranges overlap in this region just as they do in southern Texas. Geographically these forms seem to act as species in some places (as here) but as subspecies in others (Hecht and Matalas, 1946). It would seem that habitat in some way makes the difference.

10. *Pseudacris nigrita triseriata* (Wied). Very abundant throughout the county.

11. *Rana areolata areolata* Girard.

12. *R. a. circulosa* Rice and Davis. The situation regarding these two closely related frogs is puzzling. Both may occur but if so, intergrades are to be expected also. See recent discussion (Bragg, 1954, 1954a).

13. *Rana catesbeiana* Shaw.

14. *R. c. clamitans* Latreille. Abundant along the larger rivers and streams and occasionally along rocky streams and about springs. Mr. Dundee and I once found a large chorus in a pool beside the Illinois River across from the mouth of Peavine Creek and I have occasionally found an individual in the valleys of small streams entering this river. I do not know it for a certainty in the western part of the county. *R. c. clamitans* here and elsewhere in eastern Oklahoma appears to be much more secretive and shy than the subspecies occurring in the North in Maine, New Hampshire or Wisconsin, where I formerly knew it.

15. *Rana pipiens berlandieri* Baird. Abundant near water everywhere. I have found specimens here in springs, tucked in between rocks and in moss in hot dry weather.

Only one salientian not known from here now is expected. This is *Scaphiopus hurteri* Strecker, known to me north, south, east, and west of it but not as yet in Cherokee County itself. *Rana sylvatica sylvatica* Le Conte also may possibly occur but I doubt it.

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On the Occurrence of Two Species of Hylid Frogs in Virginia

By RICHARD L. HOFFMAN

In recent years data relevant to the distribution of various species of amphibians in Virginia have come to hand. Some of this information has already been published; other fragments, because of their brevity, are herewith presented collectively. These deal with range extensions, verification of previous nominal records, and local refinements of distributional patterns as currently understood.

Hyla squirella Bosc

The first and only record of the Squirrel Tree Frog as a member of the Virginia fauna is that of Dunn (1936, List of Virginia amphibians and reptiles, mimeographed, Haverford, Pa., pp. 1-5). The species was reported from Princess Anne County, without further comment, and this information is doubtless the basis for the inclusion of Virginia in the range of *squirella* in recent publications.

No Virginia material of *Hyla squirella* is cataloged in the collections of the U. S. National Museum, the Academy of Natural Sciences of Philadelphia, the American Museum of Natural History, or the Museum of Comparative Zoology. However, one specimen was found in a series of *Hyla cinerea* (U.S.N.M. 75377-81) collected at Virginia Beach in Princess Anne County. This material was at the National Museum prior to 1936, and perhaps forms the basis of Dunn's record.

The mimeographed list cited above was not widely circulated, and was never intended to be considered a "publication," so Dr. Dunn informs me. It may be of interest, therefore, to provide several distributional records which substantiate and amplify the earlier report. These are from a collecting trip in the Dismal Swamp region of Virginia, made in early August of 1946, by Hubert I. Kleinpeter and me.

On August 1, we were collecting between Sigma and Sand Bridge, in Princess Anne County (about five miles south of Virginia Beach), when a local resident called our attention to a frog which resided in his mailbox. It proved to be a *squirella,* which species was known to our informant by the name "Spring Frog." He said it had occupied the mailbox all summer. The same night, as we made camp in the dunes at Sand Bridge, we found

H. squirella to be very abundant. No less than 17 specimens were picked up as they came to the bright light of our Coleman lantern. Doubtless a larger series could have been obtained by moving the light to another location. The dunes at Sand Bridge are about 1000 feet wide, and covered for the most part by thickets of *Myrica carolinensis* and other arenaceous plants. Inland is a large freshwater lagoon, its edges choked with emergent vegetation, supporting a large population of *Hyla cinerea.* That species, *H. squirella,* and *Gastrophryne carolinensis* were all in voice. The specimens of *squirella* taken have been deposited in the collection of the National Museum.

On the night of August 2, we heard many specimens of *squirella* calling in the outskirts of Southern Norfolk, in Norfolk County, but owing to difficult circumstances no collecting was attempted.

A single male was found on the night of August 4, at Driver, Nansemond County. This specimen was heard calling, and with the exception of a lone *Gastrophryne* was the only frog in voice at the time. It was traced down and discovered in a small alder at the edge of a pond in a flat swampy pinewoods.

All of the specimens we obtained were similar in pattern—light brown or fawn with dark brown dorsal spotting. No green-phase animals were seen.

Visits to the Dismal Swamp region in March, April, and May have not produced specimens of *squirella.* Presumably in Virginia it has the latest mating season of the Hylas, and is to be looked for in early summer. Further collecting will probably provide additional locality records for the species, but it may not be found to extend farther north than Cape Henry nor inland beyond the level of the Dismal Swamp terrace. In view of its abundance at Sand Bridge, it is remarkable that *squirella* was not among the species recorded from Princess Anne County in the recent and generally exhaustive paper of Werler and McCallion (1951, Amer. Midl. Nat., 45(1): 245-252).

Pseudacris brachyphona (Cope)

In the two decades since its resurrection as a valid species (Walker, 1932) *Pseudacris brachyphona* has come to be considered more or less autochthonous to the Appalachian Plateau Physiographic Province (*cf.* Wright and Wright, 1949, Handbook of Frogs and Toads, map 16), there being no records, to the best of my knowledge, for the entire length of the Ridge and Valley Province. It is therefore of some interest to note that *brachyphona* is widespread and abundant over a considerable portion of that geomorphic entity in southwestern Virginia, and incidentally remarkable that this circumstance has for so long escaped detection.

On March 30, 1954, while driving along U. S. Hy. 52, about 7 miles west of Wytheville, Wythe County, Va., I was astonished to hear a vigorous chorus of *brachyphona* in a roadside drainage ditch. Immediate investigation indicated that about 12 males were calling; they were, however, most circumspect and fell silent on my approach. Wholesale dredging of the ditch brought up two specimens (deposited in the U. S. National Museum) as well as dozens of egg masses. Later during the same day, which was clear and hot, I heard *brachyphona* at Shawver's Mill in Tazewell County, and along Wilderness Creek east of South Gap, in Bland County. At the latter locality a specimen was seen but it escaped;

here again large numbers of egg masses, mostly very freshly deposited, were observed.

Finally, on April 6, 1954, following a hard thunderstorm, I revisited the vicinity of Wytheville, and heard a single specimen calling about five miles west of the town. This locality, then, is the easternmost known station for the species.

P. brachyphona has been recorded from Virginia only by Stejneger and Barbour (Checklist, Ed. 5, p. 45, 1943). Dr. C. F. Walker has informed me that a specimen from Buchanan County, Va., is in the collection of Ohio University, and this may be the basis of the Check List statement. On July 1, 1951, Walter B. Newman and I collected at Grundy, in Buchanan County, and heard numerous specimens calling. Fresh egg masses were found, but no adults could be collected due to their excessive shyness and our limited time.

Nearly a decade of field work in Montgomery County, Va., by Newman and me has failed to produce any *Pseudacris* except the widespread *P. n. feriarum.* A similar condition prevails farther north in Virginia, where I have collected in Alleghany County for many years without hearing *brachyphona* although it occurs a short distance to the west in adjoining Greenbrier County, W. Va. Furthermore, extensive work in Hardy County, W. Va., by L. Wayne Wilson indicates that the species does not occur in the upper Potomac drainage. It appears safe to suspect that in the northern part of its range (*i.e.*, north of the Kanawha River system), *brachyphona* is restricted to the Appalachian Plateau.

However, there is another, somewhat tentative, record to be noted at this time. On March 18, 1951, I heard several specimens of chorus frogs, which sounded exactly like *brachyphona,* in a roadside ditch at Glenvar, Roanoke County, Va. Because of circumstances at the time, collecting could not be attempted, and since later trips were unsuccessful, I came to question my identification. Now, with the capture of specimens near Wytheville, the matter is re-opened, and it seems possible after all that a colony of *brachyphona* might exist in the Roanoke Valley, far to the northeast of the presently known eastern limits of the species.

At the places in southwest Virginia where I have found *brachyphona,* it has occurred to the exclusion of *feriarum,* although the latter species could be heard calling on the same day farther northeast, in the vicinity of Blacksburg. A similar replacement has been observed elsewhere, and gives some cause to wonder if the relationship of these two frogs might be subspecific.—512 Clay St., Clifton Forge, Virginia.

Herpetological Collections from Baja California

By KEITH F. MURRAY

In the years following Linsdale's (1932) report upon collections from Baja California in the Museum of Vertebrate Zoology, a considerable number of specimens has accumulated. All of this new material is reported here except a collection made by Tevis (1944).

As earlier, nearly all the herpetological collecting was subordinate to other interests and suffered from a lack of systematic effort. The principal collecting trip involved was one of 3½ months in the spring and summer of 1948, made by Dr. Seth B. Benson, Lloyd Tevis, Jr., Jay Quast and myself. The approximate route followed was from Mexicali to San Felipe and return, thence across the Sierra Juárez to Tijuana and south along the main road to the Cape. We circled the Cape, taking a pack trip to the Sierra de La Laguna, and returned via the same route.

Other major trips were as follows: Robert R. Miller and John Davis, May 16 to June 20, 1939, in the northern part; Ira LaRivers, February to May, 1947, to the Cape and return; Seth B. Benson and Carl Koford, July 1 to August 4, 1949, the San Pedro Mártir and Sierra Juárez ranges; John Hendrickson, February 25 and 26, 1949, Todos Santos and South Coronados islands; Seth B. Benson and Lloyd Tevis, Jr., July 21 to August 3, 1950, Cedros, San Martín, San Benito islands and Cabo Tortolo on the mainland; Donald Russell, July 2 to July 28, 1950, Angel de la Guarda Island and the northern part of the peninsula. Several other shorter trips were made. A large number of *Batrachoseps* taken by Hendrickson on South Coronados Island has been reported upon by him (1954). The island trips of the west coast were all taken aboard the Orca, through the courtesy of the J. W. Sefton Foundation.

In previous accounts of the herpetofauna of Baja California information on habitat has been scanty, and an effort has been made to include such data wherever possible. Many of the specimens lack notes and a large part of the observations are my own, as are all general comments on the fauna.

I am indebted to Mr. J. R. Slevin, Dr. C. H. Lowe, Jr., and Dr. L. M. Klauber for the loan of specimens. Dr. R. C. Stebbins and Dr. R. G. Zweifel have read the manuscript and made valuable suggestions.

AMPHIBIANS

Scaphiopus hammondi hammondi Baird. Ensenada (57926).

Bufo boreas halophilus Baird and Girard. 30±mi. E. Tecate (31748-59); 1 mi. N. Neji (31744-47); 4 mi. S. Ensenada (57949-50); Laguna Hanson, 5200 ft., Sierra Juárez (51094); La Grulla, 6700 ft. (51092-93); Cataviña, 1850 ft. (50196).

The individual from Cataviña extends the known range of the species 85 miles southward from the previous southernmost record at La Grulla. This locality is well within the northern portion of the Vizcaino Desert region. Several ponds and an irrigation ditch were present, with palms and mesquite. The toad was in water flowing out of one of the ponds. Several *Bufo punctatus* were present and one (50192) was clinging firmly to the back of the toad.

A mass of eggs (31744) was taken June 13, 1939. At Laguna

Hanson, many small toads were observed and an egg mass (51094) collected on August 2, 1949. At La Grulla, there were thousands of newly metamorphosed toads on swampy ground on July 2, 1949.

Bufo punctatus Baird and Girard. E. Tecate (31763); Cantu Palms, west side Laguna Salada (31760-62); Cataviña, 1850 ft. (50192); center of Chapala Basin (51134-35); Comondú, 700 ft. (50184); Pozo Grande, 25°46′N., 112°02′W. (50185); Triunfo, 1700 ft. (50186-91); El Carrizalito, 1400 ft., 5 mi. N. Santiago (no specimen).

At El Carrizalito, toads were observed on several evenings near the end of May, 1948, at a water tank ten feet in diameter, with the water surface near ground level. Many very young individuals were around the tank for a period of time before dusk. These then disappeared while there was still daylight. At about this time, a large number of adults began to arrive from all directions, almost all together. They were silent for about 15 minutes, until near darkness, then began a loud trilling chorus. Many were in the water, several pairs in amplexus.

Hyla arenicolor Cope. Cantu Palms, west side of Laguna Salada (31764-65); Cañon de Llanos, 9 mi. SSW. Alaska (31766-79).

A tadpole (31778) was taken on June 10, 1939.

Hyla regilla Baird and Girard. 30±mi. E. Tecate (31780-85); Laguna Hanson, 5200±ft. (51091); 2 mi. (by road) W. San Telmo (54511-16); La Grulla, 6700 ft. (51090); 5 mi. N. Punta Morro Redondo, Cedros Island (51029); 1½ mi. W. Abalone Cannery, SE. side Cedros Island (23974-85); El Carrizalito, 1400 ft., 5 mi. N. Santiago (50193-94); Todos Santos (45337-48); La Laguna, 6200 ft. Sierra de La Laguna (50195).

Hylas from Cedros Island tend to lack the portion of the dark mask anterior to the eye. Several were taken in saline pools in a canyon bottom.

Rana aurora draytoni Baird and Girard. 20 mi. S. Tecate (31786-91); La Grulla, 6700 ft. (51088-89).

The frogs at La Grulla were in a clear running stream with numerous granite boulders in an area forested with Jeffrey pine.

REPTILES

Bipes biporus Cope. La Paz (44633-34).

No data are available for these specimens, collected in April, 1946.

Coleonyx variegatus peninsularis Klauber. Bahía de los Frailes (45366).

This individual, a male, coincides in every way with Klauber's (1945) diagnosis of the race. It is the fourth specimen that has been collected. A snout-vent length of 53 mm. indicates that *peninsularis* compares with *abbotti* in size and is probably not a smaller form as the previous individuals suggested. It was collected "under a rock."

Phyllodactylus unctus Cope. Bahía de los Frailes (45358-65); 6 mi. N. San José del Cabo (50036-37).

The geckos from near San José del Cabo were taken in a small cave. Those from Bahía de los Frailes were all "under bark of dead tree."

Phyllodactylus tuberculosus Wiegmann. SE. end Bahía Concepción (50035); Comondú (50034).

The specimen from Comondú was captured on a talus slope of lava rock at 8:15 P.M. on May 10, 1948.

Ctenosaura hemilopha Cope. San Esteban Island (21922-23).

Dipsosaurus dorsalis dorsalis Baird and Girard. 14.3 mi. W. Mexicali (31792); Cerro Prieto, 20 mi. SSE. Mexicali (50010-13); west side Laguna Salada (31793); Punta San Felipe (50001-09); north edge Los Machos Bay, Angel de la Guarda Island (51136-37); Laguna Agua Amarga, 20 mi. inland from Bahía de Los Angeles (51138).

Dipsosaurus dorsalis lucasensis Van Denburgh. Triunfo, 1700 ft. (50014-15); Bahía de los Frailes (45387); 3 mi. N. La Riviera (45388).

These specimens, along with a number of others in the Museum of Vertebrate Zoology, show racial differences which were not described by Van Denburgh (1920). The pattern of the back is more distinct and darker, almost black, compared with brown in *dorsalis*. There is a strong tendency toward formation of a central light band with irregular scalloped edges. Laterally, in most individuals, there are small distinct light spots with dark borders. The longitudinal lines of the gular region are considerably more distinct than in *dorsalis*.

The desert iguanas of the Cape were considerably less timid than those to the north and would often permit careful approach to within a foot. Sandy terrain seemed always preferred. Near San José del Cabo on June 2, 1948, one lizard, exhibiting apparent mating behavior, was observed chasing another. The first alternately ran and crawled, while the other followed a foot or two behind, bobbing erratically, often while in motion.

Sauromalus hispidus Steineger. 1 mi. inland from Los Machos, Angel de la Guarda Island (51154).

This individual was found sunning at 8:00 A.M. in a rocky arroyo on July 8, 1950. The vegetation was sparse with a few elephant trees, agaves and small shrubs. A great many droppings, undoubtedly of this species, were found in all parts of the arroyo. The stomach contained seeds, small fruits, stems and twigs. There were large fat globules in the abdominal cavity.

Another individual was observed lying about 15 feet high in the crown of a cardon cactus, the fruit of which was ripe.

Callisaurus draconoides draconoides Blainville. Triunfo, 1700 ft. (50047-48); San Juan de la Serradera, 1600 ft., west base Sierra de La Laguna (50050); El Chorro, 2 mi. W. Agua Caliente (50049); Bahía de los Frailes (45384).

Callisaurus draconoides carmenensis Dickerson. East end Laguna Seca Chapala (51144); 5 mi. N. Punta Prieta (51143); 10 mi. SE. Mesquital, 400 ft. (50059-61); 30 mi. SE. Mesquital (50051-52); El Arco (50053); Mulegé (50054-57); Bahía Concepción, 14 mi. SE. Mulegé (50058); east shore Bahía Concepción, 111°51′W., 26°50′N. (31866-70); 5 mi. S. El Valle, 1500 ft. (45385).

Callisaurus draconoides splendidus Dickerson. Los Machos Bay, Angel de la Guarda Island (51145-48).

Callisaurus draconoides gabbi Cope. Punta San Felipe (50038-40, 50042-46); 9 mi. W. Punta San Felipe, 200 ft. (50041); 3 mi. SW. Santa Ynez (51142).

Callisaurus draconoides crinitus Cope. 1 mi. SE. Cabo Tortolo, lat. 27°38′ (51032-41).

Petrosaurus repens Van Denburgh. Bahía Concepción, 13 mi. SE. Mulegé (50032); Comondú (50033).

Petrosaurus thallasinus Cope. La Laguna, 6200 ft., Sierra de La Laguna (50026-31); El Chorro (50022-25); El Carrizalito (50021).

These lizards were always found on granite boulders. They were timid, but when disturbed, usually retreated to the far side of the rock. At El Chorro, they were associated with *Sceloporus magister* on boulders in a wash; plants present were mesquite, palo verde, palo blanco and oaks.

Streptosaurus mearnsi Stejneger. Cañon de Llanos, 9 mi. SW. Alaska (31796-99).

Streptosaurus slevini Van Denburgh. 2.5 mi. inland from Los Machos, Angel de la Guarda Island (51139).

One was shot on a boulder at the crest of a ridge. There were numerous agaves in the area, with a few ocotillos and elephant trees.

Crotaphytus collaris baileyi Stejneger. Punta San Felipe (50016); ¾ mi. S. El Marmol (51141); 20 mi. N. Punta Prieta (51140).

Number 51141 was on a rocky slope with cardon cactus, cirio, cholla and creosote bush. Number 51140 was on a talus slope of an isolated mesa.

Crotaphytus wislizeni wislizeni Baird and Girard. 6 mi. W. Alaska (31839); 3 mi. W. Cañon de Llanos, 10±mi. SW. Alaska (31794-95); Punta San Felipe (50017); Turtle Bay (45584); 30 mi. SE. Mesquital, 600 ft. (50018); 3 mi. SSE. El Arco (50020); 20 mi. SSE. El Arco (50019).

Except at San Felipe, we found these lizards only in the Vizcaino Desert, where they were fairly abundant. Those observed ran straight, and each entered a bush at full speed. One flattened against the sand under a bush while I slowly approached and bent over it. This is a further instance of the protective behavior observed by Tevis (1944). Numbers 50019 and 50020 were females with well developed breeding coloration. They were collected on April 29, 1948, an earlier date for the appearance of this color than any records farther north. They contained ova of two and three millimeters, respectively.

Phrynosoma platyrhinos platyrhinos Girard. Punta San Felipe (50-077).

This individual was found in a small sand dune area.

Phrynosoma coronatum schmidti Barbour. Los Gavilanes, 5500 ft., 23±mi. N. Laguna Hanson (51097); Bahía Largo, 5500 ft.. 5±mi. N. Laguna Hanson (51132); Valladares, 2700 ft. (51096); San Antonio Mine, 4300 ft., 10 mi. SE. San José, near lat. 31° (51095); 10 mi. S. Laguna Seca Chapala (50071-72).

Phrynosoma coronatum jamesi Schmidt. 4 mi. NW. Mesquital (50-073); 3 mi. SSE. El Arco (50075); 11 mi. SSE. El Arco (50076); 20 mi. SSE. El Arco (50074).

These specimens appear to provide additional evidence for intergradation between the two forms *schmidti* and *jamesi* and thus to help justify the recognition of a single species throughout the peninsula. The individual from near Mesquital has black, flat temporal scales typical of *jamesi* but is intermediate in having a small fourth and a prominent fifth anterior temporal, as well as a subrictal almost in line with the sublabials.

There is a narrow zone in which a distinct change in characteristics takes place, while there is no marked shift in habitat conditions of the

area since it is in the central portion of the Vizcaino Desert. Between San Quintín and the area south of El Arco, there is great variability in the appearance of the occipital spines, interoccipitals, and to a lesser extent, in the anterior temporals. Various combinations of these characteristics occur in an irregular pattern of distribution. The situation is suggestive of a secondary contact between the forms previously considered as the species *blainvillei* and *coronatum*, in which interbreeding might be somewhat restricted.

Sceloporus orcutti orcutti Stejneger. Alaska, 4400 ft. (50068-69); Cañon de Llanos, 9 mi. SSW. Alaska, (31821-24); Tesopaco, 5500± ft., 15 mi. N. Laguna Hanson, Sierra Juárez (51102); 60 mi. S. Ensenada (57928); La Grulla, 6700 ft. (51101).

At Alaska, at the summit of the pass across the Sierra Juárez, there were many large boulders and piñon pine, scrub oak and manzanita. *Sceloporus orcutti* were numerous and invariably were seen on the boulders. Approach within 15 feet of one usually sent it into a crack with a rush.

Number 31821 was captured while it was swallowing an adult *Xantusia henshawi*, the hind legs of which were still protruding.

Sceloporus orcutti licki Van Denburgh. Espíritu Santo Island (36477-78); Cerro Agua Amarga, 4 mi. SE. Buena Vista, 23°36′N., 109°37′W. (50070).

Sceloporus magister rufidorsum Yarrow. 10 mi. SE. Mesquital (50062-64); 2 mi. S. of north end Cedros Island (45305-14).

Sceloporus magister monserratensis Van Denburgh and Slevin. Punta Arenas, Magdalena Island (54632-33); Howland's Lagoon, Magdalena Island (54634).

Sceloporus magister zosteromus Cope. Triunfo (50065-66); Buena Vista (50067).

Sceloporus occidentalis biseriatus Hallowell. Between Tecate and 20 mi. S. Tecate (31813-14); Alaska, 4400 ft. (31815-16); Cañon de Llanos, 9 mi. SSW. Alaska (31817-19); 3 mi. W. Cañon de Llanos, 10 mi. SSW. Alaska (31820); San Antonio Mine, 4300 ft., 10 mi. SE. San José, lat. 31° (51099).

Sceloporus graciosus vandenburghianus Cope. La Grulla, 6700 ft. (51098).

Uta graciosa Hallowell. Punta San Felipe (50152).

Taken in a small sand dune area.

Uta microscutata Van Denburgh. Mulegé (50153); Comondú (50154-56).

Ten miles southeast of Mesquital, on July 4, 1948, several recently hatched young were seen on a bank along a wash.

Uta nigricauda Cope. 4 mi. N. La Paz (50157-58); Triunfo, 1700 ft. (50159); Agua Caliente (45382); 6 mi. N. San José del Cabo (50162); La Laguna, 6200 ft., Sierra de La Laguna (50164); Sierra de La Laguna, 5500 ft. (45377-81); 16.6 mi. (by road) SW. San José del Cabo (50-163); El Chorro, 2 mi. W. Agua Caliente (50160-61); Bahía de los Frailes (45383).

These lizards were consistently associated with trees or bushes, usually ironwood. Most were found on branches. However, several were first located on the ground near a tree. When disturbed, each made a dash

for the tree, and upon further pursuit, would move from branch to branch, but would not leave the tree. Activity was largely confined to the late afternoon, when the heat of the day had passed. Only a few were found in the morning.

Uta stansburiana stejnegeri Schmidt. Punta San Felipe (50133-40).

Uta stansburiana hesperis Richardson. Between Tecate and 20 mi. S. Tecate (31800-01); Alaska, 4400 ft. (50141); 1 to 3 mi. W. Alaska (31802-06); 4.8 mi. W. Alaska (31807); Cañon de Llanos, 9 mi. SSW. Alaska (31809-12); North Island, Los Coronados Islands (16715); San Antonio Mine, 4300 ft., 10 mi. SE. San José, lat. 31° (51100).

Uta stansburiana elegans Yarrow. 12.5 mi. S. (by road) El Marmol, 2200 ft. (50142); La Fortuna Mine, 2 mi. N. Laguna Seca Chapala (50143); El Arco (50144); Los Machos, Angel de la Guarda Island (51149); Los Machos Bay, Angel de la Guarda Island (51150-52); 6 mi. S. San Augustin (51153); South Island, Todos Santos Islands (51180-84); Kelp Point, Turtle Bay (54629); Turtle Bay (45585-87); 1 mi. SE. Cabo Tortolo, lat. 27°38′ (51076-79); Bahía Concepción, 13 mi. SE. Mulegé (50146); Comondú (50145, 50147); San Xavier (43457-59); Magdalena, Magdalena Island (54532); 4 mi. N. La Paz (50148-51); 3 mi. N. La Riviera (45374); Bahía de los Frailes (45375).

Uta squamata Dickerson. Santa Catalina Island (43473-74).

Uta stellata Van Denburgh. Middle San Benito Island (51051-58, 51074); West San Benito Island (51059-62); East San Benito Island (51063-73).

Utas were common on these islands, where they often retreated into petrel burrows.

Uta martinensis Van Denburgh. San Martín Island (51042-45).

Common on sand dunes and flats; a few were found on lava flows.

Uta concinna Dickerson. 2 mi. S. of north end Cedros Island (45294-304); 5 mi. N. Punta Morro Redondo, Cedros Island (51075).

Xantusia vigilis wigginsi Savage. 24 mi. NW. Punta Prieta, 2000±ft. (50165); 17 mi. W. Punta Prieta (51156).

Number 51156 was taken among cirios, agaves and low brush. It was found crawling beneath the collector's truck at 7:00 A.M. on July 4, 1950. The weather was cool, the sky heavily overcast and it was lightly sprinkling. The available notes leave uncertain whether the animal was voluntarily active or had been disturbed.

The other specimen was routed from within a dead agave. The area was sandy and flat. Vegetation consisted mainly of agave, with cirios, cholla and brush.

Xantusia vigilis gilberti Van Denburgh. Sierra de La Laguna, 5500 ft. (45370-71).

Xantusia henshawi Stejneger. La Grulla, 6700 ft. (51109-17).

The spots in members of this series are larger and fewer than in representatives from southern California. There is some tendency for the formation of a continuous vertebral light band between the spots. The ground color is dark and the spots black. The two largest lizards have snout-vent lengths of 68 and 70 millimeters.

Eumeces skiltonianus Baird and Girard. South Coronados Island (51197-207); South Island, Todos Santos Islands (51191-96); La Grulla, 6700 ft. (51118).

Cnemidophorus labialis Stejneger. Socorro (50132).

Taken on a flat sandy plain where there were agave and scattered brush.

Cnemidophorus hyperythrus beldingi Stejneger. San Fernando Mission, 1500 ft. (50111).

Cnemidophorus hyperythrus schmidti Van Denburgh and Slevin. 1 mi. from SE. shore, Laguna Seca Chapala (51155); 5 mi. SSE. El Arco (50112); East shore Concepción Bay, 111°52′W., 26°50′N. (31871-73).

Cnemidophorus hyperythrus hyperythrus Cope. San Jorge, 25°44′N., 112°07′W. (50128-31); Punta Arenas, Magdalena Island (54630-31); 4 mi. N. La Paz (50113-16); Triunfo, 1700 ft. (50117-19); Buena Vista, 23°38′N., 109°41′W. (50120); San Juan de la Serradera, 1600 ft., west base Sierra de La Laguna (50125-27); El Chorro, 800 ft., 2 mi. W. Agua Caliente (50122); El Carrizalito, 1400 ft., 5 mi. N. Santiago (50121); 16.6 mi. (by road) SW. San José del Cabo (50123-24).

The above specimens make possible a better definition of the race *schmidti*. The subspecies *beldingi*, to the north, is generally distinguished by the presence of two mid-dorsal stripes, but a more consistent difference appears to be the number of supraoculars separated from the frontal by granules. The diagnostic value of this latter character has suffered through being applied in a comparison of *beldingi* and *hyperythrus* (Van Denburgh, 1922) or through an unrealistic segregation into populations of the "north" (southern California and northern Baja California) and "south" (south and central Baja California) (Burt, 1931). Of a group of 66 *beldingi* listed by Van Denburgh from southern California and northwest Baja California, 36 (54%) have granules extending forward to separate all the second supraocular, 25 (38%) have them extending forward to separate part of the second supraocular and five (8%) part of the third. Data given by Linsdale (1932) for 61 individuals from San Ignacio shows three (4.9%) with part of the second supraocular separated, 48 (78.7%) with all of the third separated, and 10 (16.4%) with part of the third separated.

Linsdale's distinction of *schmidti* from *hyperythrus* is reinforced by the present specimens. Combining data from his series from the immediate Cape region and those at hand, a total of 76 individuals, four (5.3%) have part of the second supraocular separated by granules, 44 (57.9%) have all of the third separated, and 28 (36.8%) have part of the third separated.

Comparing number of supraoculars, of 79 individuals from the Cape, 26 (32.9%) have three, 48 (60.8%) have four, five (6.3%) have three and four. For the San Ignacio series, two (3.3%) have three, 58 (95.1%) have four, and one (1.6%) has three and four.

The races are readily distinguished by the arrangement of mid-dorsal lines. In the San Ignacio series are 59 lizards (96.7%) with a fused line forked anteriorly and two (3.3%) with two separate lines. Of 81 specimens from the Cape, 55 (67.9%) have three lines, 23 (28.4%) have two lines, and three (3.7%) have a fused line, forked anteriorly. A number of those with two lines have a suggestion of a center line or the two are widely separated.

The individual from Laguna Seca Chapala resembles *schmidti* in having a single dorsal line, forked for the anterior third of its length. It

has part of the second supraocular bordered by granules, typical of *beldingi*. In these characters it is similar to a specimen from Cataviña (Linsdale, 1932), the only other one recorded from this part of the peninsula, in which the second supraocular is entirely separated by granules. Although suggestive of intergradation, these specimens are assigned to *schmidti*. It is probable that the zone of intergradation will be shown to exist a few miles to the north, in the vicinity of El Marmol.

There is also evidence concerning the relationship between the subspecies *schmidti* and *hyperythrus*. The three specimens from Concepción Bay have single dorsal stripes, forked for the anterior one-fourth, and four supraoculars. Tevis (1944) collected specimens from Coyote Bay (at Concepción Bay) and Comondú in which five have a single middorsal line forked anteriorly, two have two lines and one has three lines. From San Jorge, about 25 miles southwest of Comondú, three specimens have three stripes, one has two. Two of these have four supraoculars, two have three. The representatives at hand thus suggest that intergradation takes place between San Jorge and Concepción Bay.

The above, as well as other lizards from Magdalena Island and those recorded from Yrais, Medano and Almejas Bay by Linsdale (1932, p. 372), all appear to represent *hyperythrus*.

Cnemidophorus tigris tigris Baird and Girard. Cerro Prieto, 20 mi. SSE. Mexicali (50103); Punta San Felipe (50088-100); 9 mi. W. Punta San Felipe, 200 ft. (50101-02); Rancho Santa Ynez (50104).

Cnemidophorus tigris multiscutatus Cope. 6 mi. W. Alaska (31827); between Tecate and 20 mi. S. Tecate (31826); west side Laguna Salada (31825, 31830); 3 mi. W. Cañon de Llanos, 10 mi. SW. Alaska (31828-29); Valladares, 2700 ft. (51108); San Antonio Mine, 4300 ft., 10 mi. SE. San José, lat. 31° (51105-07); 2 mi. S. of north end Cedros Island (45286-93); 5 mi. N. Punta Morro Redondo, Cedros Island (51080); 10 mi. SE. Mesquital, 400 ft. (50084-87); Turtle Bay (45583); 30 mi. SE. Mesquital, 600±ft. (50083).

Although any conclusions concerning the recognition of the above races must depend upon more complete studies, the specimens at hand strongly support such an arrangement in this area. The lizards from San Felipe uniformly have a dark blue-gray ground color dorsally, with an indistinct pattern obscured anteriorly with a blackish suffusion. Ventrally, including the gular area, the ground color is gray. The black marks on the side of the head are blurred, and markings are blurred or absent in the gular region. There is a tendency for a blackish suffusion to be present in the chest region. With one exception these lizards are small and slender. The average snout-vent length for adults is 84.7 millimeters.

Representatives of *multiscutatus* generally have a bold and complete pattern, with distinct longitudinal light stripes. The dorsal ground color is tan, the ventral color is almost white. There are sharply defined black marks on the side of the head and in the gular region. These lizards are larger and more robust in form than *tigris*.

Of the two specimens from near Laguna Salada, one (No. 31825) appears to be a typical *multiscutatus*; the other (No. 31830) has a buffy ground color, but the pattern is much reduced. The lizard is light colored ventrally with heavy black pigment on the chest and it has the build of *multiscutatus*. This is suggestive of intergradation, which probably takes

place in the vicinity of the Cocopah Range rather than in the Sierra Juárez farther west, the main peninsular divide at this latitude.

The specimen from Rancho Santa Ynez has the build and dorsal pattern of *multiscutatus*, but is colored dorsally and ventrally like *tigris* and might be considered an intergrade.

Cnemidophorus tigris rubidus Cope. Comondú, 700 ft. (50080-82).

Cnemidophorus maximus Cope. Triunfo, 1700 ft. (50105-06); El Chorro, 800±ft., 2 mi. W. Agua Caliente (50107-09); San Juan de la Serradera, 1600 ft., west base Sierra de La Laguna (50110).

This aptly named species was common throughout the Cape region. Individuals were particularly timid and it was frequently difficult to come within pistol range of them. After dashing into a bush at high speed, they were not easily driven out in the manner of other whiptails. Their foraging behavior appeared the same as in *tigris*.

At Triunfo, many lived in brush fences. One was found in the gizzard of a roadrunner on May 30, 1948, at this locality. At El Chorro, I watched one of these lizards chase another down a steep bank. The leading lizard alternately ran and walked. Several times while running it leaped forward about three inches and cleared the ground by at least an inch. The other lizard kept pace a few inches behind, but did not leap. It was shot and proved to be a male with the right hemipenis everted.

There are no specimens to bear out the overlap with the range of *tigris* stated to exist by Burt (1931, p. 223) and shown on his range map. However, there seems to be no reason to doubt the validity of *maximus* as a species. Its distinctive size and pattern are not approached at the southern extremity of the range of *Cnemidophorus tigris rubidus*.

Gerrhonotus multicarinatus webbi Baird. San Antonio Mine, 4300 ft., 10 mi. SE. San José, lat. 31° (51103-04).

Collected in a canyon bottom with an intermittent stream bordered by oaks, sycamores and willows. The slopes above were rocky and covered with chaparral of *Adenostoma* and *Ceanothus*.

Gerrhonotus multicarinatus nanus Fitch. South Coronado Island (51185-90).

Gerrhonotus multicarinatus ignavus Van Denburgh. San Martín Island (51081-86).

The subspecific name *ignavus* was originally applied by Van Denburgh (1905, p. 19) to specimens from San Martín Island, but was casually extended by him to include the mainland population of the "San Diegan fauna" as well. All were subsequently placed in the synonymy of *webbi*, leaving *ignavus* available for the San Martín Island lizards. Fitch (1938, p. 399) noted the possible distinctness of the population, but had few specimens. A total of 20 adults now available appear to warrant subspecific status. A synonymy and description of the form on San Martín Island follows:

Gerrhonotus scincicauda ignavus, Van Denburgh, 1905, Proc. Calif. Acad. Sci. 4:19.

Gerrhonotus scincicauda webbi, Grinnell and Camp, 1917, Univ. Calif. Publ. Zool. 17: 168.

Gerrhonotus multicarinatus webbi, Fitch, 1934, Amer. Mid. Nat. 20: 395.

Type.—No. 4699, Calif. Acad. Sci., San Martín Island, Baja Calif., Coll. R. H. Beck, May 3, 1903.

Diagnosis.—Size small; temporal scales and scales at base of tail and on dorsal surface of limbs strongly keeled; number of transverse dorsal and ventral scale rows low; brown lines or a reticulated pattern present ventrally in most specimens; brown markings on top of head, on labials, and a temporal band usually present; body and limbs heavily pigmented dorsally, with transverse bands black laterally; usually a suffusion of brown on light scales between bands; white in dorsal pattern reduced, usually absent mid-dorsally; white spots on granular posterior surface of hind limbs.

Description.—Snout-vent length of 20 apparent adults 100-124 mm. (mean 111 mm.); ventral transverse scale rows 57-66 (mean 61.1±.1), counted from chin to vent; dorsal transverse scale rows 39-44 (mean 40.3±.3), counted from ear to posterior edge of hind leg; dorsal longitudinal scale rows 14 or 12+2 half scales; supralabials 10-11, infralabials 9-11; 2 upper temporal scale rows strongly keeled, 2 lower rows lightly keeled or occasionally not at all keeled (mean temporal rows keeled 3.7); dorsal and dorsolateral scales at base of tail heavily keeled, lower lateral scales lightly keeled (mean tail rows keeled 13.4); 2 to 5 (mean 3.5) scale rows keeled on forearm, 3 to 5 (mean 4.1) rows keeled on upper arm.

Ground color of head and body olive gray; top of head with dark to light brown marks or with a generally distributed light brown color; temporal band usually present, extending from eye to ear and covering lower 3 temporal scale rows; labials usually heavily marked with brown or blackish brown; 8 to 11 dorsal transverse bands, black laterally, black or brown middorsally; narrow white tips on some of dark scales at posterior edge of bands, occasionally broken into small white flecks; little or no white middorsally; strong tendency for suffusion of brown pigment over light scales between bands to form a mottled appearance; transverse bands present over all or most of tail; heavy blackish or brown marks on dorsal surfaces of limbs, forming a reticulum in certain specimens; posterior granular surface of hind limbs grayish brown with white spots.

The color pattern of the type specimen is badly faded.

Comparisons.—*Gerrhonotus multicarinatus ignavus* differs from *webbi* in having smaller average and extreme size. Fitch (1938, p. 398) gives an average size of 135 mm. for a series of *webbi* from San Diego County, with a maximum of 166 mm. The largest specimen available to me from mainland Baja California measures 158 mm. The *ignavus* series averages 111 mm., maximum 124 mm. There are significantly fewer dorsal and ventral transverse scale rows in *ignavus* than in *webbi* (Fig. 1).

The subspecies *ignavus* is more strongly keeled than *webbi*, as based on a comparison with a series from northern Baja California. Means for keeled scale rows, citing those for *ignavus* first, are as follows: temporals 3.7, and 2.8, base of tail 13.4 and 12.8, forearm 3.5 and 2.8, upper arm 4.1 and 3.8.

The subspecies *ignavus* is more darkly and heavily pigmented than *webbi*. The dorsal head marks and temporal bands are not present in *webbi*. It has darker and heavier labial markings, a greater amount of

dark pigment between the transverse bands dorsally, transverse bands darker laterally, more strongly marked dorsal limb surfaces, and a darker, more olive ground color. White in the pattern is reduced and the enlarged white markings middorsally and at the fifth lateral scale row are usually indistinct or absent. The ventral brown marks in *ignavus* appear

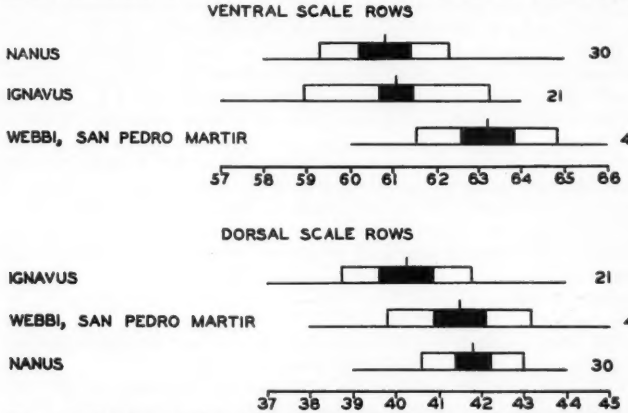

Fig. 1. Number of dorsal and ventral transverse scale rows in the subspecies of *Gerrhonotus multicarinatus*. Data for *webbi* and *nanus* are from Fitch (1938). The horizontal line indicates range, the black rectangle twice the standard error on each side of the mean, and the light rectangle one standard deviation on each side of the mean.

the same as those in *nanus*. They seem to represent a more superficial pigmentation with a less fixed position on the scales than the slate gray lines typical of the species. It is probable that these lines are generally present in life but tend to fade in preservation; they are best represented in recently and well preserved specimens.

From *nanus*, *ignavus* differs in having slightly larger body size and more strongly keeled temporals, limbs and base of tail. The former subspecies is more weakly keeled than *webbi* and there are significantly fewer dorsal transverse scale rows. In dorsal head and body pattern and color, *ignavus* resembles *nanus* except that *ignavus* has a greater amount of black. The brown ventral lines are similar. There is little difference in the number of ventral transverse scale rows.

Two small individuals measuring 42 and 51 mm. have a well developed adult type of pattern with a strongly marked brown ventral reticulation.

Material examined.—Mus. Vert. Zool. (9699-702, 51081-86); Calif. Acad. Sci. (4699, 8677, 56707, 59680-81); C. H. Lowe, Jr. (4, uncataloged), L. M. Klauber (17446-48).

Klauber (1946b) has noted that the small fauna of San Martín Island exhibits a considerable degree of differentiation, although the island is only 2½ miles from the mainland.

Four alligator lizards were captured by flashlight between 8:30 and 9:00 P.M. on a warm night, July 18, 1950; two were taken during daytime. They were found on lava only, not on sand dunes or flats.

Gerrhonotus paucicarinatus Fitch. Sierra de La Laguna, 5500 ft. (45367-69); La Laguna, 6200 ft., Sierra da La Laguna (50078-79).

Specimens 50078 and 50079 were found near running streams, one in a mouse trap at the water's edge and the other under a rock.

In one individual (50078) there is a broad longitudinal dorsal stripe of deep rust red which obscures the transverse bands.

Anniella pulchra pulchra Gray. South Coronado Island (51250-53); South Island, Todos Santos Islands (51254); Colonia Guerrero (51119).

Leptotyphlops humilis cahuilae Klauber. Punta San Felipe (50168).

Worm snakes have not previously been taken from the northeast portion of the state. The specimen was in loose sand on a bluff about 200 yards from the ocean shore. The area was mostly rocky and sparsely vegetated. The snake's head and neck were smashed, probably through trampling. The dorsal scale count is about 290; no dorsal color pattern has been retained.

Leptotyphlops humilis slevini Klauber. La Paz (45386).

The total length is 100 mm. and the ratio of body length to diameter is 50. The five median dorsal scale rows are light brown.

Lichanura roseofusca roseofusca Cope. 20 mi. S Ensenada (60725).

This boa has 226 ventrals: no dorsal pattern is apparent.

Arizona elegans pacata Klauber. 2.3 N.W. Los Martires, 26± mi. NW San Ignacio (50169).

Arizona elegans is represented in Baja California by the subspecies *occidentalis*, which extends as far south as San Quintin, and *pacata*, named from a single individual from Santo Domingo (Klauber, 1946a). Between the two is a gap of 400 miles. The present specimen was taken at a point about one third the distance north from Santo Domingo. It is a female with 41 dorsal blotches, 11 or 12 tail blotches, 208 ventrals and 42 caudals, closely resembling *pacata* in these characteristics. The blotches at mid-body are 2½ to three scales long, a condition intermediate between *occidentalis* and the specimen of *pacata*. It is probable that future collecting will reveal the familiar pattern of an area of intergradation between Rosario and Punta Prieta.

Arizona elegans occidentalis Blanchard. 10 mi N. Arroyo Seco (57930).

Lampropeltis getulus californiae Blainville. 2 mi. E San Telmo (51127).

Richard Zweifel has pointed out that two specimens in the collection of the Museum of Vertebrate Zoology (9630-31) from El Cajón Canyon, 3300 feet, at the east base of the San Pedro Mártir, which were identified by Linsdale (1932, p. 378) as *yumensis*, are on the basis of currently recognized taxonomic characters, actually *californiae*. There is no basal dark color on any of the light scales, more than half of the surface of the prefrontals is white, and the ventrals are 250 and 255 respectively

Lampropeltis getulus conjuncta Cope. North end Sierra de La Laguna (45396).

Masticophis flagellum piceus Cope. 4 mi. NW Mission Santo Tomás (50172); 10 mi. SE Mesquital, 400 ft. (50173); midway between La Paz and Todos Santos (45392); El Valle ?, 1500 ft. (45393); 3 mi. N La Riviera (45394).

All but No. 45394 represent the black phase of the color pattern.

Masticophis lateralis lateralis Hallowell. San Antonio Mine. 4300 ft., 10 mi. SE San José, Lat. 31° (51123-24).

These individuals are more heavily spotted on the chin and throat than are striped racers from southern California. The black pigment of the sides extends a greater distance onto the ventral scutes. They were taken in a canyon with steep rocky slopes covered with chaparral of chamise, *Ceanothus* and scrub oak. There was a small stream lined with oaks, sycamores and willows.

Phyllorhynchus decurtatus decurtatus Cope. 10 mi SE Mesquital, 400 ft. (50171).

This is one of a very few specimens of the subspecies and extends the known range 80 miles to the north. It is an immature female, measuring 209 milimeters. There are 176 ventrals, 24 caudals, 33 dorsal blotches and five tail blotches. Ventral and blotch counts are maximum for this subspecies, approaching *perkinsi* in the north which is recorded as extending to the Mexican border in California.

The blotches are irregular rectangles two to three scales long and five scale rows wide. The interspaces are three or four scales long. In typical *decurtatus* blotches are longer than the interspaces. This specimen approaches the condition in *perkinsi* which has blotches 1½ to two scales long, and interspaces five to seven or more. A specimen from San Ignacio, the nearest record to the south, has blotches three scales long and interspaces two or three scales long. It is probable that with additional specimens, an area of intergradation will be shown to exist a short distance to the north.

The habitat was level desert with hard packed, gravelly soil. There was a dense growth of yucca, ocotillo, creosote bush, cholla, etc., with cardons nearby.

Pituophis catenifer annectens Baird and Girard. San Antonio Mine, 4300 ft., 10 mi SE San José, Lat. 31° (51125); 3 mi. E San Telmo (51126).

Pituophis catenifer bimaris Klauber. 16 mi. SE Cataviña (45391).

The measurements of this male are: ventrals 248, caudals 64, number of dorsal blotches 42, tail blotches 10, ratio of tail length to snout-vent length .160. The first 13 and the last nine blotches are black. Aside from a somewhat higher tail ratio it is typical of *bimaris*. As in the specimen reported by Klauber (1946b) from El Marmol, slightly to the north, there seems to be no tendency to intergrade with *annectens*, which extends south on the coast to Rosario.

Pituophis catenifer vertebralis Blainville. La Riviera (45390).

Salvadora hexalepis klauberi Bogert. 8 mi. N Cataviña (45397); 10 mi. SE Mesquital, 400 ft. (50170).

The race *klauberi* was described by Bogert (1945) and included representatives from the southern and central part of the peninsula. The northernmost specimen from El Marmol was considered to be an intergrade with *virgultea*. The present specimen from near Cataviña was taken

a few miles south of El Marmol. It resembles *klauberi* in having supralabials on each side reaching the eye. The vertebral light stripe is intermediate in width, beginning three scale rows wide and reducing to one scale row and two half scale rows posteriorly. It extends faintly onto the head. The pattern appears about intermediate between examples of the two subspecies. A lateral light stripe is apparent, but not sharply defined, and is eliminated anteriorly at the 44th ventral by confluence of the dark stripes. There is a suffusion of pigment on the lower two scale rows laterally and the appearance in general is somewhat darker than *klauberi*. This individual, therefore, should also be considered an intergrade.

The specimen from below Mesquital resembles *klauberi* except that the vertebral light stripe does not extend onto the head, the lateral light stripe is poorly defined and is obliterated anteriorly, and the animal is somewhat darker. It was found lying in the open in late afternoon. When captured, it thrashed about and bit repeatedly.

Trimorphodon vandenburghi Klauber. 10 mi. N. Arroyo Seco (57931).

This is the first record of the species for Baja California. The location is apparently about 120 miles south of the Mexican border. The specimen is a small male with dark coloration and the anal plate entire. There are 228 ventrals, 69 caudals, 43 body blotches, 15 tail blotches, nine supralabials and 11 infralabials. In these characters, it is typical of *vandenburghi*. The number of body blotches is maximum for the species, in which the mean for males is 34.

Thamnophis digueti Mocquard. 23 mi. N. Comondú (45395).

This provides a fourth locality for the species, a point just below the southern end of Concepción Bay. No habitat information was available. There are now records from San Ignacio, a single specimen from Comondú, the original collection by Diguet from Mulegé, as well as the present one.

Thamnophis elegans hammondi Kennicott. La Grulla, 6700 ft. (51122).

This garter snake was captured in a clear running stream with granite boulders bordered by small willows and Jeffrey pine.

Thamnophis elegans hueyi Van Denburgh and Slevin. La Grulla, 6700 ft. (51120-21).

Number 51120 was in a clump of grass in open ground. The area was forested with Jeffrey pine.

Crotalus cerastes laterorepens Klauber. Punta San Felipe (50174-76).

Two were found active at about 9:00 P.M. The third was under rocks on a talus slope.

Crotalus enyo Cope. Punta Arenas, Magdalena Island (54636); Howland's Lagoon, Magdalena Island (54637); 5 mi. N. Triunfo (50179).

The specimens from Magdalena Island are the first from that island. One, a female, has 169 ventrals, 19 caudals, 35 body blotches and five or six tail blotches. The other is a male with 160 ventrals, 24 caudals, 31 body blotches and six or seven tail blotches. Both are distinctly paler than individuals from the mainland. The ground color is light gray, the blotches light brown with deep brown, rather than black, edging. The

side blotches are brown with just a little black. The supraocular markings are less well defined.

The animal from Howland's Lagoon was taken in an area of sand dunes.

Crotalus exsul Garman. 2 mi. S. of north end Cedros Island (45316); 5 mi. N. Punta Morro Redondo, Cedros Island (51087).

Number 51087 was on a gravel fan at the mouth of a canyon, 50 yards from the sea. It was found crawling under a bush at 8:25 P.M. Number 45316 was taken on the rocky slope of a canyon just after dark.

Crotalus mitchelli mitchelli Cope. Punta Gasparino, 23°12′N., 110°09′W. (50177).

Crotalus ruber lucasensis Van Denburgh. Bahía Concepción, 13 mi. SE. Mulegé (50182); 6 mi. N. San José del Cabo (50183).

The specimen from Bahía Concepción, a small female, provides additional evidence of intergradation between the forms *ruber* and *lucasensis* (Klauber, 1949b). It has 26 scale rows, 191 ventrals and a minimum of five scales between the supraoculars, resembling *lucasensis* in each of these characters. The number of body blotches is 32, falling between *ruber* (mean 36.3) and *lucasensis* (mean 29.9) but slightly favoring *lucasensis*. There are single loreals, typical of *ruber*.

The snake is grayish brown in color, with a conspicuous pattern. The blotches are diamond-shaped, bordered with light scale rows, and with fairly light centers. The degree to which these features may reflect the immaturity of the specimen is uncertain. In pattern and color, it resembles a young *lucasensis* from Todos Santos.

Crotalus ruber ruber Cope. San Quintín (45398); 8 mi. N. Rosario (50181); 4 mi. N. Punta Prieta (50180).

Crotalus viridis helleri Meek. La Grulla, 6700 ft. (51128, 51133); 3 mi. W. La Grulla, 6700 ft. (51129); 2 mi. NE. Jasay, 5100 ft., Sierra Juárez (51130); 20 mi. SE. Mesquital, 600±ft. (50178).

The individual from near Mesquital is distinctly light colored with a sharply defined pattern. This locality is 55 miles south of the former southernmost record at ten miles northwest Bahía Los Angeles (Klauber, 1949a). The area was flat desert with hard-packed soil and a well developed vegetation of cardon, cirio, copal, ocotillo, *Yucca* and cholla.

There are now three specimens from arid territory well south of the typical range of *helleri*, those mentioned above as well as one from Playa Mariá Bay also listed by Klauber.

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MUSEUM VERTEBRATE ZOOLOGY, BERKELEY, CALIFORNIA

AN UNUSUAL FOOD ITEM OF THE WANDERING GARTER SNAKE.—A *Thamnophis elegans vagrans* (Baird and Girard) secured about three miles southwest of Hilgard, Union County, Oregon, June 30, 1954, regurgitated a chicken bone shortly after capture. The snake measured 531 mm. in total length, the bone (a humerus) 94 mm. in length, 25 mm. in width at the proximal end and 19 mm. in width at the distal end (maximal measurements). The bone appeared to have been cooked, and the cartilaginous apices appeared to have been gnawed. No flesh remained on it. Probably this unusual and apparently unsuccessful food item was discarded by transient tourists.

Another specimen, 600 mm. in total length, secured at the same time as the preceding, contained a fish of the genus *Cottus*, measuring 100 mm. in total length.—Robert M. Storm and Denzel E. Ferguson, Dept. Zoology, Oregon State College, Corvallis.

Two British Anatomical Studies on American Reptiles (1650-1750)

II.—Edward Tyson: Comparative Anatomy of the Timber Rattlesnake

By R. H. AHRENFELDT

In the *Journal Book of the Royal Society* it was recorded that, on 13 December, 1682, "a Rattlesnake about 4 foot long brought alive from the West Indies, was sent . . . to be shown the Society; it had been 4 months in a berrell without eating" (Montagu, 1943). It is not altogether surprising that this snake, which had actually come all the way from Virginia, died soon after its arrival in England. Edward Tyson proceeded to dissect this specimen which, from his description, can be identified as a Timber Rattlesnake (*Crotalus horridus horridus* Linné).

Cole (1944) states that, although Tyson was not the first to dissect a snake, "his own description of the anatomy of the rattlesnake was the most workmanlike and accurate that had been published up to his time, and it might well have been better had his operations not been restricted to the single example available." Indeed, it is clear from the opening remarks of his paper, that Tyson was himself fully aware of these limitations: "The observations I shall here give are such as a single subject would afford, not what might compleat the history of so curious an animal. And tho it were mightily to be wisht that we had at least the most accurate account, and exactest anatomy, of one of every distinct species of animals; yet this can't be expected but of those that are most common; where frequent repeated dissections might fully inform us of Natures admirable contrivance, and mechanism of animal bodies."

Of the earlier writers who recorded their more or less detailed, or fragmentary, observations on the anatomy of snakes—Tyson's predecessors in what Cole (1944) has rightly termed "this almost virgin field"—the most important contributions were made by the following: Coiter (1573) on *Vipera b. berus* (Linné); Abati (1589) on *Vipera a. aspis* (Linné); Severino (1645, 1650) on *V. aspis* and *Elaphe q. quatuorlineata* (Lacépède); Vesling (1650, 1664)—in 1644 and subsequent years, Redi (1664), and Charas (1669, 1670), on *V. aspis;* Seger (1670)—in 1656—on *Natrix n. natrix* (Linné); Blaes (1674) on *Natrix n. helvetica* (Lacépède); and Jacobsen (1680) on *Vipera* sp., and other snakes (probably all specimens of *N. natrix*).

Tyson's account of the anatomy of the rattlesnake—which, as he rightly thought, had been "yet given by none"—was first published in 1683, reprinted in 1751, and also summarized in Latin translation (Tyson, 1684, 1693, 1720). It is important to realize that, at the time of Tyson's writing, even the most obvious characteristics and the external appearance of the rattlesnake had not so long been known to Europeans. Indeed, the first printed illustration of a rattlesnake appeared in 1628—some fifty years earlier—and there were probably not more than ten works in English, published before 1650, which referred to rattlesnakes (Klauber, 1948).

It is interesting to note, incidentally, how relatively few detailed illustrations have been published, even in recent times, showing the general anatomical relations of the viscera of snakes. In Tyson's paper, the viscera and male urogenital system of the rattlesnake, as well as its head, skull,

fangs, vertebrae and rattle, are represented in fine engravings from the original drawings by Henry Faithorne, Henry Hunt, and that most exact and talented artist and scientific illustrator, Richard Waller (Montagu, 1943). Some of these figures were subsequently copied, somewhat indifferently, by Bonnaterre (1790); but it is surprising to find that those depicting the viscera and male urogenital apparatus appeared (without acknowledgment) as late as the nineteenth century, in very poor and much reduced reproductions, in the *Cyclopaedia of Anatomy* (Jones, 1849), from which they were again copied in Richard Owen's *Anatomy of Vertebrates* (1866).

It is proposed to consider here in some detail Tyson's anatomical observations on the rattlesnakes. In this as in other investigations, Tyson never lost sight of the importance of the comparative anatomical approach, and his description of the viscera was introduced by the statement that, "for the better understanding the uses of these parts, we shall often make a comparative survey of them with those of other animals."

Sense organs.—Tyson appears to have been the first to describe and figure the loreal pit which characterizes the Crotalinae (Cole, 1944). He recorded that, between the nostrils and the eyes of the rattlesnake, "but somewhat lower, were two orifices, which I took for the eares, but after found they only led into a bone that had a pretty large cavity, but no perforation. Vipers [Viperinae] have not these orifices in the head."

West (1900) erroneously attributed the discovery of the loreal pit to Russell and Home (1804), although these authors actually referred to Tyson's observations. The presence of this organ had, in fact, already been noted, in the "fer-de-lance," *Bothrops atrox* (Linné), by several other writers after Tyson: e.g., by an anonymous writer (1786), Lacépède (1789), and Bonnaterre (1790).

The pit consists of two cavities: the inner chamber is formed by an excavation in the maxillary bone and is separated by a thin membrane (with a small perforation) from the outer one, which opens widely on the surface. That this complex sensory organ should have been mistaken by Tyson for the ear is not surprising, and, indeed, Pope (1937) observes that, "judging by its structure, the pit is some sort of an organ of hearing." However, while some experimental work has suggested that this organ may, in fact, enable the pit-vipers to detect certain air vibrations, as well as to discriminate between warm and cold objects, more recent experiments have proved that the facial pit has predominantly, and perhaps solely, the function of an infra-red receptor sensitive to variations in radiant energy (Noble and Schmidt, 1937; Block, 1950; Bullock and Cowles, 1952).

It is interesting to note, incidentally, that an accurate, and quite possibly the earliest published, account of the auditory apparatus of snakes was given by Areskine (1702): he described the stapes (columella auris), fenestra ovalis, auditory capsule, and membranous labyrinth, in *Vipera* sp., and stated that these "organs of hearing" were situated in the "temporal" (pro-otic) bones—(the wall of the auditory capsule is, in fact, formed by the pro-otic, supraoccipital, and exoccipital bones).

Tyson recorded that the eye was "in colour, the make of the pupill, and other respects, like a vipers," and described the large supraocular

scale "jetting over the eye, which seemed to serve as a palpebra for defending it from any thing falling on it." This latter observation may be compared with Cloquet's (1821) account of the similar structure in *Bothrops atrox:* " . . . the scale which is above the eye is very wide, ovate, prominent, and forms a kind of semi-operculum or superciliary ridge which overhangs the true eye-covering and protects the latter." In stating that the eye "seem'd to have a membrana nictitans," Tyson may possibly have been misled by the appearance (post-mortem) of an opaque corneal covering.

Locomotion.—The theory put forward by Aristotle (*Inc.,* 7-10, 707b-710a), as to the method of progression of snakes, was ingenious, and to this extent accurate, that it was concerned with an analysis of the mechanics of the lateral undulatory movement of these reptiles (both on land and in water), and the importance, in this connection, of the great flexibility of the intervertebral articulations. It was, however, necessarily limited, in so far as it failed to take into consideration the essential, specialized function of the ventral scales and ribs.

Tyson gave an excellent account of the anatomical basis of locomotion in snakes: "The scales of the belly were joyn'd to each other by distinct muscles; the lower tendon of each muscle being inserted into the upper edge of the following scale; and the other tendon of the same muscle inserted about the middle of the foregoing scale. . . . To each scale was appropriated a rib, whose point did joyn with the extream of it, which must much advantage the use Nature seems to design them for, by strengthening them to perform their reptile motions; for the scales are as so many feet, which being free, and open downwards, they thereby take hold of the ground, and so contract their body forwards, and then shoot out again."

He referred to the statement by Nieremberg "that on rocks their motion is much quicker than on the earth, or plains," a fact—as Tyson observed—"which he needed not to make a wonder of, since here they have the firmer footing.* But in soft ground, tho their belly be flat, yet they can contract it to an ellypsis, or an acute angle, that so they may take the deeper hold, as I have observed in a viper."

Tyson further noted that the scaly integument "is so curiously contrived, that tho it covers the whole, yet by its frequent joyntings it admits of all motions. And for this too, the vertebrae of the spine seem admirably contrived; there being a round ball in the lower part of the upper vertebra, which enters a socket of the upper part of the lower vertebra; as the round head of the thigh bone does the acetabulum of the os ischii, by which means it can turn itself any way."

Tongue and glottis—Aristotle (*H. A.,* II, 17, 508a) gave a good, if incomplete, description of the snake's tongue and glottis: he stated that "the trachea commences so close to the mouth that . . . [it] seems to project over the tongue," and that the latter "draws back into a sheath," is thin and long, and "can be protruded to a great distance. . . . It is forked at the outer extremity, and . . . the tips . . . are as thin as hairs."

* J. E. Nieremberg, in 1635, was merely repeating the earlier observation of Hernández (Ximenez, 1615), that the rattlesnake "moves over stones and crags with great rapidity, and over level ground not so rapidly, which is cause for wonder."

Tyson observed that the tongue was very protractile and consisted of a pair of long muscular cylinders, "contiguous and joyned together from the root" posteriorly for two-thirds of its length, the anterior third being bifid; and that it was enclosed in a sheath, was "fastened below the throat," and terminated near the glottis. He noted that the ununited symphysis of the mandible leaves a passage for the protrusion of the tongue: "for the better ejaculation of it, the under jaw too was here divided, leaving a considerable space." Over the tongue lay the longitudinal, slit-like opening of the "larynx" (glottis).

Respiratory system.—Tyson gave a good description of the respiratory system of snakes. He found that the trachea, "as soon as it enters the breast, . . . consists onely of semi-annular cartilages . . . joyned at both ends of the membrane of the lungs," and thus "inwardly is quite open, and immediately transmits the air to the vesiculae of the lungs;" i.e., he observed that the wall of the trachea is provided with air cells (the so-called "tracheal lung"), resembling in structure, and usually continuous with, the normal lung, and that this feature is common both to the rattlesnake and "to the viper-kind." Apart from the Crotalinae and Viperinae, it may, in fact, also occur in the Typhlopidae, and in some of the Boidae and Colubridae (Boulenger, 1913).

Tyson further observed that the lung itself was of considerable size, extending far posteriorly in the body cavity. He pointed out that its anterior part, which was highly vascular, and "was made of small vesiculae or cells," resembled the vesiculate type of lung of the Crocodilia and Salientia; whereas, posteriorly, the air cells gradually disappeared, and in their place "was only a large bladder without any cells, composed of a thin, but strong transparent membrane," which he compared with the smooth type of lung of the Caudata. In the Squamata, the substance of the lung is usually, to a greater or lesser extent, incompletely divided in this way into an anterior, respiratory part, and a posterior part having mainly the function of a reservoir for air, or "store-house," as Tyson quite correctly observed. While it is true that Blaes (1674) had already clearly recognized the morphological differences between the two parts of the snake's lung, he had not appreciated their functional significance. These two distinct functions of the ophidian lung were later confirmed by the discovery that the smooth, posterior portion may receive its entire blood supply from the systemic, and not from the pulmonary, circulation.

Cardiovascular system.—Although Tyson's anatomical observations were so accurate in many respects, he failed to give an exact or detailed account of the cardiovascular system of the snake. Indeed, this system, in the lower vertebrates, appears to have proved a stumbling block to many of the earlier comparative anatomists. Thus, as has been mentioned elsewhere (Ahrenfeldt, 1953), the first accurate account of the crocodilian heart was not published until 1825.

In the rattlesnake, Tyson noted that the heart was situated to the right of the posterior part of the trachea, and was "rather flat than round, encompassed with a pericardium." He stated that there was only one ventricle, the inside of which was "distinguish't by 4 or 5 cross furrows" —i.e., he observed the fasciculate, decussating muscular structure which occupies a large part of the ventricular cavity, but he failed to identify the

incomplete interventricular septum that arises from it and supports the septum between the origins of the pulmonary artery and left aorta.

He saw no reason "why Charas should make the heart of the viper to have two ventricles"; but it is, in fact, clear that Charas (1669), in his original description, did not even differentiate between auricles and ventricles, and believed that the snake's heart consisted of a right and a left chamber, which he termed "ventricles."

Tyson also observed the short auriculo-ventricular valve composed of two semilunar flaps. He was prepared, albeit somewhat diffidently, to concede two auricles—"one at the entrance of the vena cava, of which there are two branches descending and one ascending, the other from the arteria aorta, which has two ascending and one descending branch."

Thus, it will be seen that Tyson, who also did not mention the sinus venosus, was unsuccessful in tracing the origin of the three arterial trunks from the ventricle. From his description and figure, it is, however, possible to identify his three "branches" of the "vena cava" as the right anterior vena cava (ascending), and the (posterior) azygos vein and posterior vena cava (descending); and his three "branches" of the "arteria aorta" as the left aorta (descending), and the right aorta (and left carotid artery) and pulmonary artery (ascending).

It is true that earlier writers had, for the most part, been far less successful than Tyson in their attempts to describe the ophidian cardiovascular system. Thus, even William Harvey (1628), in his famous treatise demonstrating the circulation of the blood,* stated not only that snakes, lizards and tortoises had one auricle and one ventricle, but that the latter was "smooth within, and entirely without fibres or muscular bands"—whereas in these reptiles, as already mentioned, more than half the ventricular cavity, including the apical part, is occupied by the spongy muscular structure of the trabeculae carneae (Owen, 1866): nor does he appear to have noticed the sinus venosus. Indeed, most of those authors, previously cited, who described the anatomy of snakes prior to Tyson, gave an account of the heart which was either extremely superficial or almost totally erroneous.

Severino (1645), however, recorded that the heart of a viper (dissected in 1616) had two auricles and one ventricle, and "this seems to be the first recognition of the existence of two auricles in a lower vertebrate" (Cole, 1944). Redi (1664), who had examined a number of these vipers (*Vipera aspis*), also observed the two auricles, which, he noted, "in the natural state . . . are very small, so that some, whose eyes are not sharp enough to discern the truth, have said that the viper's heart has but a single auricle."

The first reasonably accurate account of the heart and great vessels of a snake (*Vipera* sp.) appears to have been given, in 1699, by Duverney (1702). However, the ophidian cardiovascular system was not fully elucidated until Schlemm (1826) published his careful and detailed description, based on the study of several species, and, in particular, *Constrictor constrictor* (Linné), *Lachesis muta* (Linné), and *Natrix natrix*.

* This great contribution to physiology, by one "whose work has exerted a profounder influence upon modern medicine than that of any other man save Vesalius, . . . was the most momentous event in medical history since Galen's time" (Garrison, 1913).

Body cavity.—Tyson noted that there was but a single body cavity, with no partition or diaphragm, and described the peritoneum ("omentum"), "which incompassed all parts contained in [the] lower belly; and was joyned to both sides of the ribs, so running to the rectum, and forming a bagg that inveloped the parts here, but was free, and not conjoyned towards the belly." Charas (1669) had previously described the peritoneum of the viper; and it is interesting to find that he not only mentioned the absence of a diaphragm, but, in this connection, referred to the pulmonary folds and recesses formed by the coelomic mesothelium, as follows: "It might, nevertheless, be said that that fine membrane which depends from the trachea and from the lung, and descends towards the intestines, and there takes the shape as it were of the bottom of a pouch, performs to some extent the same function."

Alimentary canal.—Tyson noted that the oesophagus was long, thin-walled, and very dilatable, and continued in a straight line to the less distensible, thick-walled, tubular stomach. He observed that the latter was lined by a mucous membrane showing marked longitudinal folds: this, he concluded, was a "glandulous coat," secreting a fluid "which digests or corrodes" the food "which they swallow always whole," as the latter could not be broken down in any other way. He noted that, after the pylorus, a short, narrow canal expanded into "a large intestine, which afforded a pleasant sight, by the weaved rugae of its inward coat; which gut, after some small windings," ended in the rectum.

Sloane (1725), who dissected a Jamaican boa (*Epicrates subflavus* Stejneger) in 1689, described the alimentary canal as follows: " . . . the oesophagus [was] pretty wide, the stomach very full of large folds; . . . the intestine was one strait duct without circumvolution down to the anus; the excrement soft and whitish like that of a bird."

In the stomach and intestinal canal, Tyson observed "abundance of *Lumbrici teretes,* which is a disease vipers likewise are subject to." Nematode infestation is, in fact, very common in snakes (Boulenger, 1913; Baylis, 1951). It is interesting to note that, in the following year, Redi (1684) not only recorded the presence of nematodes in a bicephalous snake, but also correctly recognized the immature, encysted forms which he found in the liver, as belonging to the same species of roundworms as that which he had found, in the adult form, in the snake's intestine. Indeed, twenty years earlier, Redi (1664) had already recorded that he frequently found more than thirty nematodes ("lombrichi") in the stomach and intestines, and in the trachea, of a single *Vipera aspis*—an anatomical distribution most characteristic of these parasites and determined by their life cycle. The presence of nematodes in the alimentary canal of snakes had also been noted previously by Aldrovandi (1640), Vesling (1650, 1664), and Jacobsen (1680).

Liver, biliary system, pancreas and spleen.—In snakes, the posterior extremity of the long and narrow liver is bilobate, and Tyson noted that this organ "seemed divided on one side by the vena cava into two lobes of an unequal length," and that the gall-bladder was "seated at some distance below it." He stated that, while the cystic and common bile ducts ("ductus cysticus" or "ductus bilarius") were quite evident, the hepatic duct was hard to find; and he correctly described the course of the former ducts from the anterior end of the gall-bladder, through the

middle of the pancreas, to the beginning of the intestine. It should be noted, however, that Charas (1669) had already given an equally detailed description of the liver, gall-bladder and biliary ducts of *Vipera aspis*. Sloane (1725) also noted, in 1689, that the gall-bladder, in *Epicrates subflavus*, was very large and round, and situated "a pretty way under" the liver.

In the Serpentes, the hepatic duct is of great length, and the gall-bladder is removed beyond the liver to the side of the narrow canal connecting the stomach with the intestine. Indeed, this fact was already known to Aristotle (*H. A.*, II, 17, 508a, b; *P. A.*, IV, 2, 676b), who stated that, while in some animals the gall-bladder was attached to the liver, in others it was separated from that organ and, in snakes, was "usually beside the gut"; but that, in both cases, it seemed to be "an appendage of the lower stomach" (i.e., connected with the most proximal, post-pyloric part of the intestine).

Owen (1866) pointed out the obvious advantage of this modification of the biliary system in snakes: had the gall-bladder been attached to the liver, as in insectivorous Sauria, it would have been compressed by the stomach, when the latter was distended by the frequently large bulk of the prey, and this would have led to the premature expulsion of the bile into the intestine; the gall-bladder is so placed, however, as to be stimulated to empty its contents only when the narrow canal leading to the intestine becomes distended by the gastric contents passing through the pylorus, and the bile is required for the duodenal digestive processes.

The bile in most reptiles is green, and bitter to the taste (Owen, 1866)—a fact which was observed by Tyson in the rattlesnake and in *Vipera berus;* and also by other writers, in various species of snakes, e.g., *Vipera aspis* (Charas, 1669), and *Epicrates subflavus* (Sloane, 1725). It was, however, found by Hunter (1861) to be "a pale clear yellow colour" in *Pelamis platurus* (Linné); and similarly by Seger (1670) in *Natrix n. natrix*—("vesica bilaria . . . succo flavescente tenui repleta").

Tyson found an organ which was "about the bigness of a large bean; . . . it adhered to the side of the intestine at the beginning of it; and . . . through the middle of it . . . the ductus bilarius did pass." He concluded that this was the spleen, although it had been correctly identified by Charas (1669) as the pancreas. "Indeed in vipers," Tyson commented, "the colour of this part, and situation so neare the intestine, seems an argument for Charas his conjecture . . . ; but here in our subject, its colour which was deep red, . . . as likewise its figure, not spreading but more compact, these seem to favour the opinion of the Ancients" that it was the spleen.

In fact, the color and the form of the pancreas are subject to considerable variation in different orders and species of reptiles: in *Crotalus horridus*, it is of a compact triangular form, closely attached to the commencement of the intestine, and perforated by the biliary ducts (Owen, 1833, 1866).

Charas' (1669) account of this organ (in *Vipera aspis*) deserves to be quoted: "The pancreas, which all authors have called spleen, is situated close to and slightly below the gall-bladder, and on the right side of the viper; it is as large as a good-sized pea; its substance is apparently fleshy, but in fact glandular. Its situation, which is directly

adjacent to the lower end of the stomach, and towards the entrance to the intestines, considered together with its glandular substance, leads me to believe that it is a pancreas rather than a spleen; on this point, however, I leave the decision to those who shall take the trouble to examine it." It may be noted, incidentally, that Cope (1900), in his diagram of the viscera of *Crotalus v. viridis* Rafinesque, erroneously labeled the pancreas, "spleen" (although the spleen is also figured).

Both the spleen and the pancreas were, in fact, observed and correctly described, respectively, in various species of snakes, by Severino (1645), Vesling (1664), and Seger (1670), although these authors failed to recognize the pancreas as such. However, Blaes (1674) and Jacobsen (1680) correctly identified these two organs in snakes, and the former, in particular, gave a good description and figures of the pancreas, spleen, gall-bladder and biliary ducts, and their anatomical relations, in *Natrix n. helvetica.*

The spleen itself is very small in snakes, and is closely applied to the anterior border of the pancreas. It is just possible that Tyson might, on closer inspection, have observed (but not necessarily identified) the true spleen, had he not been, as he informs us, "taken off from a farther scrutiny into this part by the ravishing beauty of another, . . . the kidneys."

Urogenital system (male).—Tyson gave an excellent account and figure of the urogenital system of his male specimen of *Crotalus h. horridus.* It is true that, in the figure, he confused the relations of the vas deferens, ureter and renal portal vein (and, indeed, he also failed to make them clear in the text). That this error may have been, as Cole (1944) suggests, that of the artist, would seem unlikely in view of the evidence available, in Tyson's paper and elsewhere (Montagu, 1943), as to the very great care and attention which Tyson personally gave to the illustrations, as well as the general presentation, of this work. More probably, it was due, in part at least, to the fact mentioned by Tyson—who obviously did not dissect under water—that so much time was spent on the drawings, for the sake of accuracy, that the parts had dried before he was able to examine them thoroughly.

Tyson noted that the kidneys were elongated and situated dorsally on each side of the spine, "but not very firmly conjoyned" (i.e., loosely attached to the dorsal abdominal parietes), and that the right kidney was somewhat longer than the left. He did not, however, show this unequal development in his figure, nor did he mention or depict the difference in the levels at which these organs are situated, although Vesling (1650), Charas (1669), Blaes (1674), and Jacobsen (1680), had previously recorded the fact that the left kidney in snakes is lower than (or posterior to) the right—that "tandem arrangement" in the Serpentes, as Quiring (1950) aptly describes it, which is "an expression of inner stream lining which reflects that of the body form."

It may here be mentioned incidentally, that this relationship between body form and the morphology of certain internal organs was dealt with, on a comparative anatomical basis, by Tyson in his paper on the rattlesnake: nor, indeed, had it escaped the attention of Aristotle (*H. A.,* II, 17, 508a; *P. A.,* IV, 1, 676b), who observed that, "a serpent's body being long and narrow, its contents are as it were molded into a similar form, and thus come to be themselves elongated."

Tyson noted that the kidneys, "tho one continued body, [were] yet plainly distinguishable into several lesser kidneys." Charas (1669) similarly stated that, in the viper, "they are composed of several glandular bodies, contiguous, and arranged side by side, one after the other"; and this lobulation of the ophidian kidney was also mentioned by Severino (1645), Vesling (1650), Blaes (1674), and Jacobsen (1680). The renal lobules in snakes are, in fact, "flattened and overlapping" (Owen, 1866); and Sloane (1725), in 1689, quite accurately recorded that the kidney of *Epicrates subflavus* was "made up of several small lobes laid one on another."

The whole kidney, Tyson observed, "seemed a delicate compages [tissue] of vessels, and the intermixture of those of the blood, with those other white ones, that are the secretory, composed most regularly formed bodys." Along each kidney, he found two large blood vessels, one on either side, (the renal portal veins, or venae renales advehentes, and the right and left branches of the posterior vena cava, or venae renales revehentes, respectively); "and from these arise several lesser branches at set distances [afferent and efferent renal veins], which curiously spreading themselves do forme as it were ramifications of trees. As many as there were of these emulgent vessels . . . , so many kidneys [lobules] were in each [kidney]; the interstices of these blood vessels were filled up with other white ones, which I doubt not are for the secretion of the urine."

This is a remarkably detailed account of the relatively complex structure of the reptilian kidney, and in particular that of snakes in which each lobule "is so distinct that it may be regarded as a separate kidney or renule." On each surface of the lobule are the radiating branches of the ureter, which are "dispersed fan-wise, . . . and are often seen injected, as it were, by the opaque white pultaceous urinary excretion." Similarly, the branches of the renal portal vein are "distributed fan-wise over both surfaces of the flattened renule" (Owen, 1866). These superficial venous and ureteric ramifications are very clearly shown in Tyson's figure.

Tyson compared the lobulated renal structure which he found in the snake, and which, to a greater or lesser degree, characterizes the metanephros of the lower Amniota in general, with the structure of the mammalian kidney. The latter, he observed, was often less elongated and more compact than the former, "the several glandulous bodys that compose them being conglomerated, and closer set together; tho in some they appear perfectly distinct," as in the Ursidae and Cetacea, in which the kidney is divided into a large number of lobes, each with its own capsule, and a distinct pyramid and pelvis: "And the kidney in a man tho it seems but a single one, yet is really made up of as many as there are corpora papillaria [pyramids]."

It may readily be conceded that, in the metanephroi of the Amniota, the renal substance can be regarded as divided, in one way or another, as it were into more or less distinct groups of nephric units—the collecting tubules from each group opening into a branch, or radiating branches, of the ureter, or, at the apex of a pyramid, into one of the calyces of the renal pelvis (cf. Romer, 1949). Indeed, according to Owen (1868), one of the chief modifications of the kidneys in Mammalia is "in their composition by a seeming multiplication of simple kidneys, either with or without a common cortical envelope."

So, too, in the rattlesnake, Tyson concludes, "tho the substance of the kidney seems continued, yet there ought to be reckoned as many as there are distinct systems and orders of vessels; each making a peculiar gland or small kidney; which, according to the advantage of the body of this animal, are placed here at length, not piled on one another."

According to Aristotle (*P. A.* III, 8, 671a; IV, 1, 676a), no reptile, excepting the tortoise, had a urinary bladder. In fact, however, a bladder is found not only in the Testudines (Testudinata), but also in *Sphenodon punctatum* and in most Sauria; it is absent in some lizards, and in the Serpentes and Crocodilia (Romer, 1949). The absence of a urinary bladder in snakes was noted by Vesling (1664), Blaes (1674), and Tyson.

Tyson found that the ureters, in the male rattlesnake, after running along the kidneys and receiving branches from the lobules, "did terminate near each other in the cloaca, making a riseing there" (the urogenital papillae); and that, in the female *Vipera berus,* the cloaca received not only the ureters, but also "the two uteri" (oviducts). Redi (1664) similarly pointed out that the ureters of snakes opened, not into the rectum—as had been stated by Vesling (1650, 1664)—"but in a small, raised slit situated, in females, between the orifices of the two uteri [oviducts]." Redi also stated that he had sometimes found small calculi in the ureters, and in the substance of the kidneys, of *Vipera aspis.*

Tyson observed that the rectum opened into the cloaca, "yet had a convenient valve that covered it"—i.e., the incomplete transverse septum or fold separating the anterior chamber of the cloaca, which receives the rectum, from the posterior chamber, which receives the openings common to the ureters and vasa deferentia, or the separate openings of the ureters and oviducts.

He described and figured the two elongated "scent-baggs" (anal glands) which lie in the base of the tail, and their orifices near the anal vent: "The liquor included in them was something crass, and of a strong and very unpleasant smell; such, but in a more intense degree, as the animal did emitt before dissection." These organs were not, as has been stated by Cole (1944), first discovered by Vesling in 1644. They were already mentioned and figured by Abati (1589), who described them, in the male *Vipera aspis,* as "vasa praeparantia semen in . . . penibus per suas venas" ("vessels supplying the semen to the penes through their veins"); and as both he, and Aldrovandi (1640) who copied Abati's figure, also stated that the viper had four testicles, it may be inferred that they regarded these glands as accessory testes.

Vesling (1650) and Charas (1669) also recorded the presence of the anal glands in male specimens of *Vipera aspis,* believing them to be seminal vesicles. Charas, indeed, commented that "those who have taken these two reservoirs of semen for additional testes, have been very much mistaken." But, as Tyson pointed out, it was, in fact, Charas who was mistaken, "as likewise those he would refute that would have them to be other testicles: and I the more wonder at this his mistake, since he could not but have observed them as I have in the female vipers too; which sufficiently shews his error." It is certainly strange that neither Vesling nor Charas, both of whom had dissected male and female specimens of *Vipera aspis,* and described their anatomy, did not observe these

organs in the female, in which (as in other species of snakes) the anal glands are much larger than in the male.

It is interesting to compare Tyson's observations on the odor emitted by the Timber Rattlesnake with those recorded, apparently also in *C. h. horridus*, by Weir Mitchell (1861): "When a rattlesnake is roughly handled, . . . a very heavy and decided animal odor is left upon the hands of the observer. . . . Thin streams of a yellow or dark brown fluid are ejected. . . . This fluid appears to come from glands alongside of the cloaca. Its odor is extremely disagreeable."

Tyson noted that the secretion of the anal glands of "our common snakes" (*Natrix n. helvetica*) has "a far greater foetor" than that of "our adders or vipers" (*Vipera b. berus*): in the latter, as Malcolm Smith (1951) points out, this secretion "is odorless, at any rate to us." Redi (1664) stated that, in general, vipers (*Vipera aspis*) do not emit any odor. He appears, however, to have been the first to note the presence of anal glands in the *female* viper, for he remarked that, on compression not only of the two "genital members" of the male viper, as in many other snakes, but also of the two organs of the female viper *"resembling seminal vesicles"* ("quasi vesichette seminali"), "which depend close to the two openings" of the oviducts, there was emitted a fluid "with a strong, offensively feral, odor peculiar to snakes"; and he asserted that, in vipers, this unpleasant odor was emitted by "the genital parts alone."

In most snakes, the secretion of the anal glands has a strong, offensive odor, although in some species of Boidae it is said to have a musky odor which has been variously described as "not unpleasant" (Angel, 1950), in *Python molurus* (Linné) and *P. spilotes* (Lacépède), and as "disagreeably sweet" (Gadow, 1901), in *Boa* spp. However, "de gustibus et odoribus non disputandum." *

There is much variation among different species of snakes, in the readiness with which this fluid is discharged as a defense mechanism (or possibly, a fear reflex). The habit appears to have been most frequently observed in certain colubrid genera of the subfamily Colubrinae: e.g., in North American species of *Elaphe, Natrix* and *Thamnophis* (Schmidt and Davis, 1941); in the European species, *Elaphe l. longissima* (Laurenti) and *Natrix* spp. (Rollinat, 1946); and in the species, *Natrix piscator* (Schneider) and *Ptyas mucosus* (Linné), of India and South-East Asia (Wall, 1921).

In his description of the male genital organs of the rattlesnake, Tyson noted that the testes were white, elongated, and narrow ("scarce so big in compass as a goose-quill"); and that they were "very unproportionate in length," the right one being longer than the left—a fact which, as he pointed out, had already been observed (in *Vipera aspis*) by Charas (1669). Indeed, Charas—as well as Severino (1645), Vesling (1650), Blaes (1674), and Jacobsen (1680)—had also correctly recorded the relative positions of these organs in snakes, the left testis being situated at a lower level than (or posterior to) the right; Tyson did not mention this point, and his figure erroneously represents the testes in juxtaposition.

* The odor emitted by snakes has been mentioned by many early authors, from Aelian (*N. A.*, IX, 44), in the third century A.D., who stated that it emanated during copulation, to Jan de Laet (1633) who recorded that, in some Brazilian snakes, it was "similar to that of young foxes" and, in others, resembled musk.

Tyson also noted that the ovaries, in a female *Vipera berus,* were unequally developed on the two sides.

Tyson observed the "vasa praeparantia" of the testis, which may have been either the ductuli efferentes, or, more probably, the seminiferous tubules (which can be seen through the thin, translucent tunica albuginea); and he remarked, in a most descriptive alliteration, that "the whole testis is but a congeries [collection] of curiously convoluted vessels."

He recorded that the vasa deferentia, "tho they did run in a strait line almost from the testes to the penis, and did form no large body," were nevertheless so convoluted that they would, if unraveled, be twice their apparent length. He concluded that what appeared to be the vas deferens in the snake was, in fact, "only the extention of the epidydymis."

Charas (1669) gave a reasonably accurate account of the epididymis of *Vipera aspis:* "From the middle of each of these testes, from their internal aspect, there is seen to emerge a small body, long and slender, fairly firm, and even somewhat whiter than the substance of the testes, which descends, and is attached to them in its entire length, as far as their inferior extremity." He also described the "spermatic vessel" (vas deferens), commencing at the posterior end of the epididymis as "a small varicose vessel . . . which is slightly flattened, of an intense white color, and fairly shiny. . . . This vessel is rather delicate, and is convoluted throughout its course."

In snakes, the epididymis forms a long, narrow band, which lies along the dorsomedial side of the testis: its medial part consists of a strongly convoluted ductus epididymidis, continued caudally, with no sharp delimitation, by the similarly convoluted vas deferens (Volsoe, 1944). Thus, the epididymis and vas deferens have the appearance of a continuous, narrow, convoluted tube running in a straight line from alongside the testis to the cloaca. It will, therefore, be seen that, in view of the somewhat special arrangement of these organs in snakes, the early descriptions by Charas and Tyson are remarkably detailed and accurate.

Tyson did not correctly trace the course of the vasa deferentia to their opening in the terminal part of the ureter. He could not investigate this point in the rattlesnake, as the parts had dried before he was able to examine them; but on dissecting a male *Vipera berus,* he formed the opinion that the vas deferens continued along the penis, dividing with that organ so as to run to the extremity of each bifurcating branch: i.e., he believed that it was continuous with the sulcus spermaticus, pointing out that there were neither vesiculae seminales nor "prostates" (accessory glands) to receive the vasa deferentia. Abati (1589), Vesling (1650), and Charas (1669), stated that the vasa deferentia terminated in the anal glands which, it will be recalled, they had mistaken for accessory testes or seminal vesicles.

Tyson described and illustrated the structure of the hemipenes of *Crotalus h. horridus* and *Vipera b. berus.* He stated that, in the rattlesnake, there appeared to be two penes on each side, "which lay sheathed in the body [so] that upon first opening it they were not to be perceived, but only the large orifices where they were drawn in as a finger of a glove may be by a thread fastned to the end." On everting these organs, he observed "that toward the basis, or root, they were single on each side,

and that here they were thick beset with prickles whose points looked backwards, and were very sharp, and seemed . . . like the substance of the bristles of a hedg-hog; but hence they were divided, and did form two round bodys. . . . When protruded, I found they could easily be retracted . . . by the help of large muscles, that were fastned to them and did run along under, and were at last inserted at the end of the tayle at the setting on of the first rattle." Each of these large retractor muscles, or, as Tyson already named them, "retractores penum" (magni), is attached to the two branches of a hemipenis, and is inserted into the last caudal vertebrae (Volsoe, 1944).

As Tyson pointed out, earlier writers—such as Abati (1589), Aldrovandi (1640), Vesling (1650), and Charas (1669)—had mistaken these muscles (in *Vipera aspis*) for the penes, which they described as extending to the tip of the tail. Charas, however, also mentioned that each penis is provided with "erector muscles" (probably, the small retractor muscle), and, toward its opening, is "surrounded by a very strong and thick muscle, to which the skin is firmly attached" (the propulsor muscle).

Tyson correctly observed that the spines of the hemipenis are recurved toward its base and that, whereas in *Vipera berus* they cover the organ as far as its apex, in the rattlesnake they are restricted to its lower, or middle part (Volsoe, 1944; Cope, 1900).

Discussing the specialized structure of these organs, he concluded that their bifid extremity and spines had the function of preventing withdrawal during mating, and ensuring a better connection with the oviducts and a firmer union than would be effected by the intertwining of the snakes' bodies alone. And, indeed, Volsoe (1944) states that "the hemipenis is firmly anchored in the female cloaca by means of the strong, hooked spines, and during this phase the two partners can be separated only with difficulty. The two branches of the hemipenis probably fit into the dorsal recessus of the female cloaca, one on each side of the median fold, so that the ends come into direct contact with the openings of the oviducts."

Cope (1900) stated that, in those species of snakes in which the hemipenis is provided with spines, the walls of the vaginal recess of the female cloaca are found to be correspondingly tough—a fact which was noted by Charas (1669) and Tyson, in *Vipera aspis* and *V. berus* respectively.

Charas (1669), somewhat quaintly, appears to have attributed masochistic tendencies to the female viper, asserting that, in the act of mating, "she suffers, and even experiences pleasure from the pricking of the spines of the male's members." Tyson put forward an alternative theory that, since female vipers "are naturally so cold and frigid," the spines might possibly "serve to incite them, and stir them up."

Whatever the solution to this fascinating psychosexual problem, which might well tax the ingenuity even of Dr. Alfred Kinsey, "we shall pass off," as Tyson next observed, "from these parts, that serve for increasing themselves, to those that often prove the Destruction of Others, the Poysonous Teeth."

Teeth and poison apparatus.—Tyson noted that the rattlesnake had two kinds of teeth. "The lesser, which . . . serve for the catching, and retaining of food," were situated in rows on each side, in the lower jaw (mandibular teeth) as well as in the upper jaw, where some were placed

anteriorly and some posteriorly (palatine and pterygoid teeth, respectively). "The poysonous fangs, which kill" the prey, were placed externally in the upper jaw, to the front of the mouth; they were not attached to the "maxilla" (as he mistakenly, but understandably, termed the palatopterygoid arch) as were the other teeth. The "two outmost and largest fangs," Tyson found, were fixed to a bone which "may be thought to be the eare bone": in fact, it is these two functional fangs that are ankylosed to the actual maxillae, in the external sockets of these bones.

Tyson's conjecture, that the maxilla was the "ear-bone," was not, however, so far-fetched as it might at first appear: for, in the Crotalinae, the outer surface of the maxillary bone is characteristically hollowed out above, to form the inner cavity of the loreal pit; and, indeed, the latter bears some apparent resemblance to an organ of hearing.

"These fangs or larger teeth," Tyson recorded, "were not to be perceived upon first opening the mouth, they lying couched under a strong membrane or sheath; but so as did make a large riseing there on the out side of the lesser teeth . . . ; but at pleasure, when alive, [the snake] could raise them to do execution with; not unlike as a lyon or a cat does it's claws."

He observed and figured the series of developing or reserve fangs, which showed a progressive decrease in length posteriorly from the functional fangs. The fangs were "hooked and bent," and numbered on each side "about 6 or 7"; they were not placed exactly in line, and the second fang (i.e., the first reserve fang) "did lye more on the side of the first; and the other being fastened only to muscles or tendons which are flexible, 'tis difficult to assign them their posture."

Tyson's account of the structure and function of the canaliculate fang of the Solenoglypha shows an equally careful attention to detail. He found that each of these teeth, "especially the larger," had "a pretty large foramen or hole towards the root of it, and towards the point there was a plain visible and large slit, like the cut of a pen sloping; and that part from the slit to the root was perfectly hollow; which first of all was discovered to us, by pressing gently with our finger the side of the gumme; for then we did perceive that the poyson did readily arise through the hollow of the tooth, and issued out of the slit."

In fact, according to Klauber (1939), in a typical series of reserve fangs in rattlesnakes, in all but the first reserve fang the upper lumen is not yet formed, and the lower lumen is still incomplete or absent in the last two or so of the developing series. Tyson's figure shows the upper lumen, at least partially formed, in the first three reserve fangs of his rattlesnake. Rufz (1859), in his detailed study of *Bothrops atrox*, found that, of a series of reserve fangs, "the more developed show the beginning of a more or less definite, though incomplete, alveolar orifice [upper lumen], but all have the [lower] elliptical orifice"; and his excellent illustration shows the upper lumen partially formed in all but the last two reserve fangs, and in the latter, the lower lumen present but incomplete.

In any case, a perusal of Klauber's (1939) most careful and thorough study of the structure and development of the fangs of rattlesnakes reveals

the surprisingly detailed and accurate nature of Tyson's early observations, in the single specimen that he was able to examine.

As a result of damage caused to his material by his extensive investigations of the poison fangs, Tyson was unable to examine the venom glands. These had, however, already been described, in *Vipera aspis,* by Redi (1664) and Charas (1669). According to Cole (1944), Coiter gave "an account of the poison glands of vipers almost a century before Redi, who is usually credited with having been the first to do this."

It would, however, seem that the structure described in *Vipera berus,* by Coiter (1573)—as also that mentioned by other early writers after him—was, in fact, not the venom gland (which, if seen, would probably not have been recognized as such), but the dilatation of the venom duct and its expansion into a pocket in the fold of the gum at the base of the fang. He stated: "I observed some recurved and very pointed teeth, flanked on either side, externally to the row of [pterygoid and palatine] teeth, by a vesicle situated beneath the eye, which contained a greenish venom. Among these teeth, there were two outer ones, prominent and recurved, beneath which were placed some others, and all of them were bound together by a small muscle."*

Thus, Redi (1664) would indeed seem to have been the first, not only to describe the actual poison gland of snakes, but also to differentiate clearly between the "sheaths of the teeth" ("guaine de' denti")—and, from his description, this term certainly included the pocket in the fold of the gum—and the venom glands ("glandule") themselves. He gave a good account of the canaliculate fangs and the series of reserve teeth, in *Vipera aspis,* and assumed that the poison ran from the glands through "salivary" (venom) ducts to the fold of the gum at the base of each fang; but, curiously enough, he mistakenly believed that the venom flowed externally along the tooth, and not through the canal and foramina, although it had actually been recorded, in the first century A.D., by Pliny (*N.H.,* XI, 62) that, in vipers, the fangs "are perforated with a small tube in the interior . . . and it is through these [teeth] that they eject their venom."

Tyson noted that the venom of the rattlesnake was a clear, pale yellow fluid. He referred to the contemporary controversy between Redi (1664, 1670, 1673) and Charas (1669, 1670, 1672, 1673), as to the nature and origin of the poison of the viper. Francesco Redi—one of the most outstanding contributors to the development of experimental biology and medicine, and the first to confute the doctrine of spontaneous generation (Garrison, 1913; Castiglioni, 1947)—asserted that the poison was to be found in the secretion of the venom gland, and in this opinion he was supported, in England, by Tyson and Richard Mead.

Charas, on the other hand—like Severino (1650) and others before him—had "espous'd a notion, that this poison does not lye in the yellow liquor of the gums, but in the enraged spirits of the viper" (Mead, 1702); upon which view Redi (1670, 1673) commented as follows: "I should think it very well worth while for those learned authors of the book of

* ". . . vidi aliquot dentes incuruatos, acutissimosque vesiculae vtrinque a lateribus seriei dentium externis, sub oculis collocatae, quae subuiride continebat virus, inclusos. erant inter eos dentes duo insignes exteriores et incuruati, sub his alij aliquot positi, & omnes musculo paruo alligati."

the *New Experiments,* that they would please to make their experiments anew. And if they shall find them conform to those they have already published, and really contrary to mine, then we may unanimously conclude, that we have lighted upon a truth hitherto unknown; which is, that the poison of the French vipers consists in an imaginary idea of a revengeful anger; but that of the Italian ones hath its seat in that yellow liquor, so often mentioned by me."

Skeleton.—Tyson gave a reasonably good, though incomplete, account and figure of the rattlesnake's skull. He did not identify the component bones of the solidly ossified cranium, but mentioned the nasal bones, and also the "bones which divide the nose" (which, as his figure clearly shows, represent the vomers, turbinals and premaxilla).

He noted that "the other bones seemed admirably contrived for the great extension, and widening of the maxillae [jaws]; which seems a great provision of Nature; for since [the snake] must swallow all things whole, and its head is but small, without this most mechanical contrivance it were impossible to do it."

He described the relations between the several bones involved in this process. The "upper jaw" (palatopterygoid arch) became broader posteriorly, but anteriorly, "divided into two bones" which articulated with "the bone of the poysonous fang" (maxilla), one externally (ectopterygoid), and the other—"which received the small teeth"—more medially (palatine and pterygoid). The maxilla, as has already been mentioned, was believed to be the "ear-bone," as its excavation, which was found to communicate externally with the open cavity of the loreal pit, "was thought to be the foramen of the ear; but inwards we observed no perforation for a nerve."

Tyson correctly noted that the articulations between the maxilla, the prefrontal, and the cranium (frontal), and those between the palatopterygoid arch and the maxilla, seemed "advantagious . . . for the motion of the fang, which lyes sometimes couch'd, sometimes erected." He further pointed out the advantageous mechanism for swallowing large prey, provided by the articulation of the jaws posteriorly with the quadrate bones which, "from their use," he named the "maxillarum dilatores;" by the articulations between the cranium (parietal), and the squamosal (supratemporal) and quadrate bones; and, also, by the fact that the mandibles were not fused, but connected at the symphysis by a very extensible elastic ligament.

He observed that the mandible consisted of two bones firmly connected: an anterior bone provided with small teeth (dentary), and a posterior one broadening towards the articulation of the jaws (articular).

Klauber (1939) has given an excellent account of the highly specialized mechanism for tilting the fangs, which is provided by the above mentioned series of articulations between the bones of the upper jaw.

It may also be of interest here to record that the skull, fangs, venom glands and ducts, and the muscles and ligaments connected with the poison apparatus, in *Vipera* sp., were described in some detail by Areskine (1702); and that, some years later, Nicholls (1745) gave an accurate and well illustrated account of these structures, in *Vipera berus* and "an exceeding large rattle-snake" (*Crotalus* sp.).

On counting the vertebrae of the rattlesnake, Tyson noted that "from the neck to the anus there were as many observed [as] scales on the belly, viz. 168, but from the anus to the setting on of the rattle 29 more in number than the scales." He also stated that the ribs terminated at the extremities of the ventral scales. He did not, however, correlate these two observations.

Charas (1669), on the other hand, recorded not only that the ventral scales, in *Vipera aspis,* were equal in number to the vertebrae extending from the beginning of the neck to the root of the tail; but that these were the vertebrae bearing ribs, of which each pair terminated at the margins of a ventral scale, whereas the caudal vertebrae, from the base to the tip of the tail, did not carry ribs. Thus, in the viper, he concluded, "there are as many large scales beneath the belly, . . . as there are vertebrae provided with their pair of ribs."

These early observations are of interest, in view of a recent suggestion that this anatomical correlation might provide a basis for standardizing the method, in taxonomy, of counting the ventral scales of snakes; and it was found, in this connection, that the ventral count in specimens of ten genera of Colubridae agreed exactly with the number of dorsal vertebrae (Dowling, 1951). The relationship between the number of dorsal vertebrae and the ventral scale count was also found to be constant in *Bothrops atrox* (Rufz, 1859).

Tyson described the ball-and-socket articulation of the procoelous vertebrae, and the compressed and truncated neural spines. He correctly noted and illustrated the characteristics of the dorsal vertebrae—the single hypapophysis, the posterior zygapophyses and zygantra for articulation with the adjacent vertebra, the diapophyses with articular tubercles for the ribs, and the parapophyses; and also the distinctive features of the caudal vertebrae — the double hypapophysis, and the elongated diapophyses "something analogous to ribs," of which the most anterior do, in fact, support short ribs which usually become ankylosed to their extremities (Owen, 1866).

The rattle.—Finally, Tyson observed that the rings of the rattle "are placed with their broadest part perpendicular to the body, not horizontal;" and that the first proximal segment was attached to the last caudal vertebra "by means of a thick muscle under it, and by the membranes that conjoyn it to the skin."

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Aelianus—*N.A.* = De Natura Animalium.
Aristoteles—*H.A.* = Historia Animalium.
P.A. = De Partibus Animalium.
Inc. = De Incessu Animalium.
Plinius Secundus—*N.H.* = Naturalis Historia.

(Roman numerals = Book; Arabic numerals = chapter.)

BINSTED PLACE, NEAR ALTON, HAMPSHIRE, ENGLAND

A CLUTCH OF EGGS OF *ANEIDES HARDYI* (Taylor).—Lowe (Copeia, 1950: 94) first described finding a clutch of eggs of *Aneides hardyi* (Taylor) at Cloudcroft, Otero County, New Mexico. This clutch of three eggs was found within a large, moist, decomposing Douglas fir log, on a steep north-facing slope; each egg contained a larva which had the customary leaf-like, flat, allantoic gills, typical of the genus *Aneides*. The eggs were also pedicelated, the individual pedicels being twisted about each other in a grape-like cluster. No other clutches of eggs of the Sacramento Mountain salamander have been reported, although Stebbins (Amphibians of Western North America; 1951:138) mentions the clutch found in August, 1949, by Lowe and Norris.

On August 12, 1954, Daniel R. Stanland and I collected *Aneides hardyi* at a locality 0.7 mi. E. Cloudcroft. The locality here is a steep (40%) north-facing slope immediately above a paved road. The flora is typical of these high elevations (9000 feet) in New Mexico, the forest consisting predominantly of Douglas fir *(Pseudotsuga taxifolia)*, spruce *(Picea pungens)*, and yellow pine *(Pinus ponderosa)*. The ground is well littered with fallen logs and branches, and rocks of various sizes. Seventeen individuals of this amphibian were taken, all from within decayed and extremely wet fir logs. No salamanders were collected from beneath the many rocks present, although the earth was quite moist.

A clutch of ten eggs and an accompanying female (ChM 54.178.58) were discovered by Stanland. The eggs were found about four inches within a decaying fir stump, the wood of which was quite moist. As is usual in *Aneides*, the eggs were suspended by their pedicels from the roof of a crack in the moist wood; the female was not coiled about them when discovered, but was moving off into the mass of the stump to avoid capture. As far as could be ascertained, the pedicels were not intertwined as in the clutch described by Lowe. However, nine of the eggs apparently had a common point of origin.

Study of the remaining lot of salamanders collected at the same locality shows that three other individuals (two from ChM 54.178.57 and one in the collection of the writer, No. 424) are gravid females. In all the ova are well-yolked; females with snout-vent lengths of 50 mm., 55 mm., and 53 mm., respectively have 9, 10, and 11 eggs in the oviducts. The condition of these eggs indicates that possibly they would have been deposited shortly.

The ten eggs collected have been measured in the laboratory. The greatest diameters, transversely, vary between 6.1 mm. and 7.4 mm. (mean—6.8), while longitudinally, the diameter varies between 7.4 mm. and 9.1 mm. (mean—8.1 mm.). The enclosed larvae are well developed, with the yolk sac protruded from the mid-gut, the limbs and digits present and pigmented with small, dark chromatophores, and with flat, trilobed, unpigmented allantoic gills.

Residents of Cloudcroft stated that the weather had been extremely wet during the latter part of July and early August, and the extreme wetness of the decayed logs and beneath rocks testifies to this fact. During our two day stay at Cloudcroft, the weather was rainy and almost continually overcast, with cool temperatures (near 60° F) during the day.—Albert Schwartz, The Charleston Museum, Charleston 16, South Carolina.

A New Sheep Toad (Genus *Hypopachus*) from Mexico

By WILLIAM B. DAVIS

In the course of a survey of the vertebrate fauna of the Mexican state of Guerrero, field parties of the Department of Wildlife Management, Texas A. and M. College, collected a series of 52 toads of the genus *Hypopachus* from near the town of Almolonga (= Amula), which lies at an elevation of 5600 feet between Tixtla and Chilapa, east of Chilpancingo. Ecologically, this region appears to be associated with the Balsas Basin and not with the Sierra Madre del Sur. Consequently, it is not surprising that among the recognized species of *Hypopachus* in Mexico these toads are most closely allied to *H. alboventer* Taylor from Morelos. However, they are recognizably different, especially in the presence of numerous pearly spicules on the dorsum and of conspicuous reticulations on the venter of most specimens.

The presence in males of a distinct, large thoracic gland on the breast and upper abdomen in *H. alboventer, H. maculatus* Taylor from Chiapas, *H. oxyrrhinus* Boulenger from Sinaloa, Jalisco, and Michoacan, and in the series from Almolonga seems to justify the concept that these four populations are genetically more closely related to each other than they are to any of the other known forms of *Hypopachus* in Mexico. No other species of *Hypopachus* that I have examined has this peculiar gland.

H. maculatus differs, however, from *alboventer* and the specimens from Almolonga in (1) more extensive webbing on the hind foot and (2) the presence of a distinct, light dorsal stripe. *H. oxyrrhinus* differs from both *maculatus* and *alboventer,* and the population at Almolonga, in having shallow webbing between the toes of the hind feet and further from *maculatus* and *alboventer* (but not from the population at Almolonga) in having the venter boldly reticulated. Consequently, it appears that *H. maculatus* and *H. oxyrrhinus* are specifically distinct from *H. alboventer* and the Guerreran population, and that the last two populations represent an allopatric species composed of two geographic races, one of which lacks a name. For this last population I propose the name

Hypopachus alboventer reticulatus subsp. nov.

Holotype. Texas Cooperative Wildlife Collection No. 10855, male; collected by Ralph W. Axtell, 2 miles south of Almolonga, 5600 feet, Guerrero, June 24, 1954; original No. 1232.

Paratypes. TCWC Nos. 10807-10854 (all males); collected by Axtell with the holotype; TCWC No. 10804, male, collected by James R. Dixon, at the type locality June 23, 1954; TCWC No. 10805-06, males, collected by Dixon at the same locality June 25, 1954.

Diagnosis. Similar to *Hypopachus alboventer* Taylor, but venter of most specimens distinctly reticulated and the dorsum pustular, each pustule with a pearly spicule; chin, sides, tops of legs, back of femur and forearm, and tops of hands and feet with numerous spicules.

Comparisons. Agrees with *H. alboventer* from Morelos, *H. oxyrrhinus* from Sinaloa, and *H. maculatus* from Chiapas in presence of well-defined glandular region on breast and upper abdomen and in general

proportions. Differs from *H. maculatus* in having venter distinctly reticulated in most specimens, in absence of median dorsal line, in less extensive webbing on the hind foot, in relatively smaller eye, and in the presence of numerous pearly spicules on upper parts. Differs from *H. caprimimus* Taylor from Agua del Obispo, Guerrero, in smaller size, markedly different color pattern, more pustular dorsum, and presence of large thoracic gland; from *H. ovis* Taylor from Nayarit in larger hands (toads of comparable body size compared), more extensive webbing on hind feet, more pustular dorsum, absence of light dorsal stripe, and presence of thoracic gland; from *H. oxyrrhinus* Boulenger in more extensive webbing on hind feet, more pustular dorsum; from *H. cuneus* Cope in presence rather than absence of webbing between toes, dorsum pustular rather than smooth, and absence of dorsal cream colored line.

All of our specimens were taken at a temporary rain pool at the beginning of the rainy season.

I am indebted to Dr. Hobart M. Smith, University of Illinois Museum of Natural History, for the loan of specimens of *H. ovis, H. maculatus,* and *H. oxyrrhinus* for comparative purposes.

DEPARTMENT OF WILDLIFE MANAGEMENT,
TEXAS A. AND M. COLLEGE, COLLEGE STATION, TEXAS

HABITAT DISTRIBUTION AND MOVEMENTS OF *BUFO B. BOREAS.* BAIRD AND GIRARD.—During the summer of 1949 studies were made along the Oregon Coast between Florence, Lane County, and Reedsport, Douglas County. This area has a variety of habitats: salt and freshwater marshes, sand dunes, herbaceous, shrub, lodge-pole pine, Sitka Spruce, Cedar-hemlock.

After very little study, it was possible to distinguish Northwestern Toad tracks with certainty. It was found that if tracks that appeared fresh were followed at night, toads might be found. Tracking led the author to believe that movements were either confined to or much more numerous at night.

Toads occupied a wide variety of habitats in the coast strip. Their tracks were most prevalent in sand dune areas, but were also extensive in shrub and Sitka Spruce climax habitats. The only toad observed during the daytime was under a dense layer of shrubbery in a moist Sitka Spruce habitat.

Some Bufos are known to have traveled long distances, although the abundance of invertebrates along their pathway belied any premise of food searching. Whether these excursions are caused by food specialization, which is doubtful in view of the known food habits of the form, wanderlust, or some other unknown factor cannot be hypothesized from the data obtained. There was much interlacing of the tracks of these toads, and it was a rare occasion when one animal's travels could be traced over any great distance. On one fortunate instance, the tracks of one individual, known to be made during the previous night, were followed one morning for more than a half mile over and around dunes before being lost in the puzzle of other toads' tracks.—Richard A. Pimentel, Biological Science Dept., California State Polytechnic College, San Luis Obispo, California.

Additional Notes and Descriptions of Plethodontid Salamanders from Mexico

By CARLOS B. BUMZAHEM and HOBART M. SMITH

In a collection of reptiles and amphibians collected by Mr. Eizi Matuda between 1944 and 1949 in the Región de Soconusco, Chiapas, Mexico, were a number of interesting salamanders of the family Plethodontidae. Two of the forms appear new to science, another new to Mexico. We wish to thank Dr. L. C. Stuart for his many kind suggestions and aid in making comparisons.

Pseudoeurycea goebeli Schmidt

One specimen (UIMNH 34223) in poor condition appears to be referable to this species. *P. goebeli* has not previously been recorded in Mexico, but recognition of this species as an addition to the herpetofauna of Mexico must be considered tentative due to the poor condition of the specimen. Further investigations in this general area will probably establish this and other Guatemalan forms not previously recorded as a portion of the Mexican faunal assemblage.

The specimen is dark brown (in alcohol) except for a slightly lighter gular area and a reddish brown diffusion on the dorsal surface of the body and tail; the parasphenoid teeth are in two distinct, elongate patches; total length approximately 142 mm.

Pseudoeurycea brunnata sp. nov.

Holotype. University of Illinois Museum of Natural History, No. 33708, an adult female collected in the Región de Soconusco, Chiapas, Mexico, between 1944 and 1949, by Mr. Eizi Matuda.

Paratypes. UIMNH Nos. 33703-33707, 33709-33720, nine females, seven males, and one juvenile collected by the same collector in the same locality.

Diagnosis. A *Pseudoeurycea* having about 25 premaxillary and maxillary teeth on each side; 13 costal grooves, 2 to 4½ folds between adpressed limbs; web including about half of proximal phalanx of middle digits.

Description of holotype. Body of normal form; head wider than neck; length of eye slightly longer than distance between anterior corner of eye and tip of snout; tail slightly longer than head and body; 13 costal grooves, counting one each in axilla and groin; 4 costal folds between adpressed limbs; a well-defined groove from near posterior corner of eye to end of nuchal fold; gular fold present; web including about half of proximal phalanx of middle digits; toes slightly flattened, truncate; premaxillary and maxillary teeth about 25 on each side.

Color above (in alcohol) light brown, sides and belly darker; lower surfaces, except for belly, light brown.

Head-body length 60 mm; tail 62 mm; axilla to groin 32 mm; width of head 9 mm; head to gular fold 13.5 mm; arm 14 mm; leg 15.5 mm.

Variation. Seventeen paratypes are available for comparison. Accurate count of premaxillary and maxillary teeth is difficult but all seem to agree with the holotype in having about 25 on each side; all have 13 costal grooves; the number of costal grooves between adpressed limbs varies from 2-4½; the tail is not always longer than head and body but may be slightly shorter. Five of the paratypes (UIMNH 33709-10,

33713, 33718-19) differ in coloration (in alcohol). These have the entire ventral and lateral surfaces darkly pigmented, with the exception of one specimen (UIMNH 33719) which has a light gular area, but has more of the sides and dorsum darkly pigmented than any of the others.

Remarks. P. brunnata does not seem to be as closely related to the Mexican forms previously described as it is to the Guatemalan *rex* and *goebeli*, and indeed is the first member of the genus described from Chiapas.

It may be distinguished from the Mexican species by its lack of dorsal red or red-orange markings, premaxillary teeth of males not bifid, web including only about half of proximal phalanx, less than 30 premaxillary teeth on each side, tail 90 to 100 percent of body length in most cases, and adpressed limbs separated by more than one costal fold.

It differs from *goebeli* in having more than one costal fold between adpressed limbs, and from *rex* in size and coloration. Large specimens of *rex* range from 85 to 99 mm, while the largest *brunnata* reaches 122 mm total length. *P. rex* always has the underside of the tail black, while in almost all of the specimens of *brunnata* available the underside of the tail is light.

Magnadigita brevipes sp. nov.

Holotype. University of Illinois Museum of Natural History No. 33694, an adult female collected in the Región de Soconusco, Chiapas, Mexico, between 1944 and 1949, by Mr. Eizi Matuda.

Diagnosis. A *Magnadigita* with short legs; about 13 costal grooves, counting one each in axilla and groin; 5½ costal folds between adpressed limbs; vomerine teeth about 15-17 on each side. Color (in alcohol) brown with a series of yellow and yellowish-green blotches along the sides.

Description of holotype. Body form robust; snout truncate; horizontal diameter of eye equal to distance from eye to tip of snout; canthus rounded; gular fold present; about 13 costal grooves, the posterior ones indistinct; 5½ costal folds between adpressed limbs; limbs short; combined leg and arm length 72% of axilla-to-groin length; marked constriction at base of tail; tail short, 42% of the total length. Tips of digits very truncate, webbing never including most distal phalanx except on digit I.

Color of body and head (in alcohol) above a somewhat reddish brown; sides, venter, and entire tail a dark brown; a series of yellow and yellowish-green blotches extending along sides from level of forelimb almost to level of hind limb; a few smaller spots on the neck and belly, those on belly almost obliterated; a few indistinct spots present on limbs.

Total length 157 mm; snout-vent 90 mm; tail 67 mm; axilla-groin 51 mm; head length to gular fold 19 mm; limb length to tip of longest digit 18.5 mm.

Remarks. M. brevipes does not seem to be closely related to any of the Mexican forms but appears to be most closely related morphologically to the Guatemalan *M. morio* and especially *M. omniumsanctorum*. It differs from *morio* in having more than two costal folds between adpressed limbs, greater size, and lack of spots or a band on the dorsal surface. According to the original description *omniumsanctorum* has the sides lighter and heavily flecked with white, venter light brown powdered with white, limbs brown flecked with white above and marbled brown and

white below. *M. brevipes* has the sides darker and covered with large yellowish blotches; venter dark brown with no trace of powdering but an occasional indistinct blotch; limbs brown with a few indistinct light spots but not marbled brown and white below. The vomerine teeth of *brevipes* are somewhat more regular in arrangement and more numerous than in either *morio* or *omniumsanctorum*.

MUS. NAT. HIST. AND DEPT. ZOOL., UNIV. ILLINOIS, URBANA.

Range Extensions of Certain Amphibians and Reptiles of Southern Mexico

By HOBART M. SMITH and W. LESLIE BURGER

The collections of reptiles and amphibians secured by Mr. Thomas MacDougall and Mr. W. Leslie Burger in the states of Oaxaca, Chiapas and Puebla, Mexico, in 1949 and 1950, and by Mr. Eizi Matuda in Chiapas from 1944-1949, include several noteworthy range extensions. All catalog numbers cited refer to the collections of the University of Illinois, Museum of Natural History.

Bufo bocourti Brocchi

Five specimens (Nos. 33520-3, 33855) are from Región Soconusco, 1944-1949, collected by Eizi Matuda. Four are males, all with a light tan dorsal color, no middorsal light streak, belly nearly or quite unspotted, and maximum snout-vent length 73 mm. The single female is strikingly different in appearance, being mottled with black above on a light tan background; with a broken but broad and distinct middorsal light stripe; a dorsolateral light streak, irregular and poorly defined; belly, throat and ventral surface of limbs spotted; and snout-vent length 77 mm. Four others from Guatemala, made available through the courtesy of Dr. L. C. Stuart, appear to bear out the indication that these differences are sexually dimorphic.

This species has not previously been recorded in Mexico from a more restricted locality than "Chiapas" (Stuart, Copeia, 1951: 220).

Bufo marmoreus Wiegmann

A single, subadult female No. 34224) from the Región Soconusco, Chiapas, 1944-9, collected by Mr. Eizi Matuda, is referable to this species, and extends the known range about 200 miles (from the vicinity of Tehuantepec, Oaxaca), suggesting that it may well occur in Guatemala. With its well-defined, *fowleri*-like markings and semicircular interorbital crests it cannot be referable to *B. perplexus*, a very similar species previously recorded from Chiapas (Tonalá).

Two additional specimens (Nos. 9667-8) were collected by W. Leslie Burger at Rancho San Bartolo, Chiapas, on August 4, 1949. The single adult has the markings and crests typical of the species.

The two localities here cited are the only ones recorded for the species in Chiapas, although the range was stated by Smith and Taylor (Bull. U. S. Nat. Mus., 194, 1948:45) to extend from Sinaloa to Chiapas.

Bufo perplexus Taylor

Three specimens (Nos. 9594-6) were collected by W. Leslie Burger on July 3, 1949, at a locality one mile north of Tehuitzingo, Puebla. They were found at night by gasoline lantern. The species has been reported in the adjacent states of Morelos, Guerrero, and Oaxaca, but has

not heretofore been known from the state of Puebla. The actual distance involved in the range extension is but about 85 miles. The specimens possess the peculiar reticulate pattern and angular supra- and postorbital crests characteristic of the species.

Hyla arenicolor Cope

Two specimens, an adult (No. 9760) and a small juvenile (No. 9761) were collected by W. Leslie Burger on August 24, 1949, from rock faces near a waterfall in a small stream 20 mi. SE Huajuapam de León, Oaxaca. The nearest localities of previous record are about 100 miles to the west, in Morelos and central Guerrero. The extension of the known range into Oaxaca is paralleled by the ranges of numerous other reptiles and amphibians of the Pacific slopes of Mexico.

Rana pustulosa Boulenger

A single specimen (No. 9849) was secured by W. Leslie Burger on Aug. 24, 1949, at the edge of a small stream 20 mi. SE Huajuapam de León, Oaxaca. This locality is about 125 miles east of the nearest locality previously recorded for the species in central Guerrero. The present example is typical, with dim, scattered dark spots, pustular skin, blunt tips on the toes, and a poorly developed dorsolateral ridge. Like the preceding, *Hyla arenicolor*, this species on biogeographic grounds was to have been expected in western Oaxaca.

Phyllodactylus magnus Taylor

A single specimen (No. 34215) from the region of Soconusco, Chiapas, collected by Eizi Matuda, 1944-9, extends the known range of this species southward about 100 miles, suggesting that it very likely occurs in adjacent Guatemala. The specimen is not in good conditon, but it seems to agree with the most salient characteristic of *P. magnus* in having six rows of tubercles on the tail.

Celestus rozellae Smith

A large adult (No. 35818) was found by Mr. Thomas MacDougall in December, 1951, at La Gloria, in the northeastern part of the state of Oaxaca, Mexico, on the eastern side of the Isthmus of Tehuantepec. The species has been reported previously only from Palenque, Chiapas, and Piedras Negras, Guatemala, localities about 190 and 230 miles by air to the east. All localities lie in a continuous belt of humid rainforest on Atlantic slopes at elevations close to 1000 feet above sea level. These localities embrace a large part of the Palenque Province of the Atlantic sub-region of Mexico (Smith, 1949, Ann. Assoc. Amer. Geogr., 39: 226, 228, 234-435). Thus the distribution now known is in accordance with zoogeographic expectation.

The specimen measures 103 mm. snout to vent; tail regenerated; snout to posterior border of ear 21.8 mm.; foreleg 21.5 mm.; hind leg 27 mm. Scale rows 33 at midbody; 9-9 supralabials to posterior edge of subocular; nasal in contact with rostral; 19-19 lamellae on free part of 4th toe. Other scale characters and the color are essentially as described for the type (Smith, 1942, Proc. U. S. Nat. Mus., 92; 372-3).

Of special interest is the occurrence of this species in the same area as *C. enneagrammus* Cope, a specimen of which (No. 36130) was secured at the same locality (La Gloria) as that at which the *C. rozellae* was taken. The specimen is a young example measuring 44.5 mm. from snout to vent, tail 64 mm.; scale rows 33; 8 supralabials to rear of subocular; rear of

first labial even with middle of naris; median loreal longer than anterior, about equal to posterior. In these and in other morphological features the specimen agrees well with near-topotypic examples (Nos. 19515-6, 1-3 mi. W. La Joya, Veracruz) and all differ consistently from *C. rozellae*. Yet in pattern No. 36130 is very distinctive, being uniform dark above except for a wide bluish line extending from the rostral through most of the length of the tail. The stripe occupies the middorsal scale row or its equivalent and, in the lumbar region, the edges of the adjacent rows; it gradually becomes narrower and less distinct distally on the tail.

Thamnophis sumichrasti fulvus (Bocourt)

A single adult female (No. 33665) from the region of Soconusco, Chiapas, collected 1944-49 by Eizi Matuda, completely lacks stripes and has only small flecks evident on either side of the middorsal line. This represents the first definite record of this subspecies from Mexico, although it has previously been thought to occur.

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Observations on the Feeding Habits and Growth of Immature Diamondback Terrapins

By J. FRANCES ALLEN AND ROBERT A. LITTLEFORD

Studies on the general biology and culture of the diamondback terrapin are in no sense new, since as early as 1906 Coker described in some detail the biology, feeding habits, and reproduction of this species. Additional information has been reported by Hildebrand (1929, 1932) and Hildebrand and Hatsel (1926).

As a result of the work noted above, the general features of the life cycle, growth, and feeding habits of this reptile are well known. However, no detailed studies of any particular phase of the biology of the diamondback terrapin are available. In order to fill some of the gaps in our specific knowledge, the present investigation of the feeding habits and growth of newly hatched terrapins was initiated.

The specimens used in this study were obtained from Beaufort, North Carolina, and represented a portion of a shipment of newly hatched terrapins delivered to the University for release in suitable habitats. A total of 875 individuals were observed during the period of this investigation. Unfortunately, many of these individuals were hybrids between *Malaclemys c. centrata* and *M. c. concentrica* (Hay 1905, Hildebrand 1933), thus the data presented cannot be said to apply specifically to either subspecies.

Rearing of diamondback terrapins under laboratory conditions poses problems with respect to sanitation, water supply, methods of feeding, and avoidance of the development of "soft shells." After considerable trial and error, during which all methods suggested by previous investigators were tried, the authors adopted a relatively simple plan for rearing the terrapins.

The terrapins were divided into groups of 20 and each group was

placed in a glass aquarium of 6 gallon capacity, which was equipped with a turtle adapter made of slate. Each aquarium measured 17½ by 9½ inches inside and was 9½ inches in heighth. Water having a salinity range of between 12 and 18 parts per thousand was collected from nearby areas of Chesapeake Bay and added to the aquaria. The water level in the aquaria was maintained so that approximately one-third of the sloping slate surface was covered at all times. The aquaria were cleaned weekly and each time a new supply of water was added. No attempt was made to provide facilities for hibernation, as one of the objectives of the study was to determine the extent of feeding and growth in a non-hibernating population. All experimental animals were kept in the laboratory, where the temperature range was between 20° and 26° C. inclusive.

The individual terrapins were marked for identification by the use of red nail polish, rather than paint, applied to selected plates of the carapace. This system afforded an identification which remained permanent for at least six months, was easily replaced, and did not result in injury to the animal or loss of the identification by obliteration (Cagle 1939, Hildebrand and Hatsel 1926).

The terrapins were fed three times a week and at each feeding were removed from the aquaria and placed in pans with water and food. After feeding, the terrapins were washed thoroughly and returned to the aquaria. All food was chopped as fine as possible and a sufficient quantity was available at each feeding so that some was left after all specimens had finished. This method had the advantage of allowing the smaller and apparently weaker specimens, that normally would be forced away from the food, an opportunity to feed.

The use of 2 inch square pieces of copper screen in the aquaria to prevent "sore tail" and "soft shell" diseases as recommended by Hildebrand and Prytherch (1947) was found to be totally ineffective. However, copper pennies served the same purpose very effectively, and it was observed that as the terrapins increased in size many of them would carry the pennies around the aquarium in their mouths. The method of rearing terrapins as described above proved highly effective in that cleanliness was easily maintained and disease was observed in less than 2% of the population.

OBSERVATIONS

Of the 875 terrapins started initially, 752 survived until the end of the first year. The remaining 123 died either because of a failure to feed or, in the case of 68 individuals, a failure to feed combined with the effects of a two day period when the temperature in the laboratory rose to 32° Centigrade. It is of interest to note that this high temperature did not have a lethal effect upon the terrapins that had been feeding.

In order to determine food preferences of the terrapin, the following items were offered: crabs, oysters, clams, marsh snails, mussels, fresh fish, canned fish such as tuna and salmon, liver, and beef. At the outset, the terrapins accepted all of these items without any discrimination. After three weeks of feeding, however, the tuna and salmon were refused and the terrapins would go without eating rather than consume these items. Liver, likewise, proved to be unacceptable to the majority of the terrapins and the few that fed on this material showed a rather lethargic type of

behavior. On the other hand, liver could be substituted once every one or two months in any of the diets and was accepted by the terrapins.

As compared to the aforementioned foods, all terrapins showed a definite preference for fresh fish, crabs or crab meat, various shellfish, snails, and beef. Of these foods, shellfish and snails were preferred over fish, crabs, and beef. This observation supports the brief data of Coker (1906) who noted that fragments of *Littorina irrorata* and other gastropods were found in greatest abundance in the stomachs of 14 young terrapins captured in Beaufort Harbor. From these data, Coker concluded that *Littorina irrorata* was one of the chief sources of food of young terrapins under natural conditions. Contrary to the statement of Hildebrand and Prytherch (1947) that beef does not produce rapid growth and healthy animals, the 75 terrapins that were reared exclusively on a beef diet for three years showed the same rate of growth and at the same time appeared as healthy as, and more alert than, those reared on a mixed diet.

The observations on feeding of newly hatched terrapins show that they are rather indiscriminate in their initial feeding habits with respect to animal sources of food. After three weeks of feeding, however, they become more selective in their choice of food and will refuse items that are unpalatable. Moreover, food preferences are developed, and once these preferences become firmly established, it is extremely difficult to break the feeding pattern. The terrapins reared on a beef diet (raw steak and lean beef chopped fine), for example, consistently refused to accept any other type of food. Of the 875 terrapins observed, only 123 or 14.06% failed to feed. This indicates that the majority of newly hatched terrapins are able to feed without undergoing a period of hibernation.

In order to investigate the rate of growth of young terrapins, 200 individuals were reared on a mixed diet consisting of fresh fish; clams, *Mya arenaria, Tagelus plebeius,* and *Venus mercenaria*; oysters, *Crassostrea virginica*; and snails, *Littorina irrorata,* and *Melampus b. lineatus.* A definite feeding routine was established in which fish, clams, oysters, and snails were fed regularly in that order. At the end of the first year, the number of terrapins was reduced to 100 because of the increase in size that had take place. At the end of the second year, the terrapins were released, as plans for moving the laboratory to another building would have resulted in an interruption of the observations. Significantly, no deaths occurred in this population.

The general summary of the data with respect to the increment of length and of weight is presented in Table I. Length was determined by measuring the plastron to the nearest tenth of a millimeter by the use of vernier calipers. All weights were made on an analytical balance. Since the young terrapins arrived initially in late September, all measurements and weights were made on October 1 of each year.

TABLE I. Length and Weight Increments of Diamondback Terrapins Through Two Years of Age

Year	Number of Terrapins	Length in MM. Range	Length in MM. Average	Weight in Grams Range	Weight in Grams Average
Initial	200	27.1–32.8	30.65	4.40– 7.85	6.485
End of 1st yr.	200	59.5–65.5	61.93	75.20– 95.80	81.83
End of 2nd yr.	100	68.5–95.7	89.63	134.60–153.70	143.08

The data presented in Table I show that the average initial length of the terrapins was 30.65 mm. At the end of the first year of growth, the length range extended from 59.5 through 65.5 mm., with an average length of 61.93 mm. An average increment of length of 31.28 mm. is reported for the first year's growth. These results compare with those reported by Hildebrand and his associates for growth of young terrapins reared under different conditions and are slightly higher than those reported by Coker (1906) from measurements of captured individuals. Growth during the second year was somewhat less than that in the first year, in that the average length of the terrapins at this time was 89.63 mm., an average increase of 27.70 mm. in length as compared to 31.28 mm. for the first year of growth.

Increase in weight, as would be expected, showed the same trend as that of length. By the end of the first year, an average weight increase of 74.345 grams was observed. This may be compared to an average increase of 61.25 grams during the second year of growth.

In conclusion, it may be pointed out that, under clean conditions, terrapins will grow as rapidly and survive as well under laboratory conditions as under natural conditions. The young terrapins are indiscriminate in their initial feeding habits, but rapidly develop food preferences that are difficult to break. Reared on a diet of fresh fish, shellfish, and snails, individuals in the laboratory showed growth just as rapid as that taking place under natural circumstances.

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